THE

ELECTRICAL REVIEW.

VOL. XL. JUNE 25, 1897. No. 1,022.

CONTENTS:

	PAGE
Dynamos	865
Western Electric Non-Sparking Brushes (*illustrated*)	867
Recent Progress in Röntgen Photography (*illustrated*)	867
Vertical Compound Electric Railway Engine (*illustrated*)	868
Electrical Transmission of Power in a Colliery	868
Reviews:—The Materials of Construction	869
The Engineer's Sketch Book of Mechanical Movements	870
The Institution of Civil Engineers (*concluded*)	870
The Motor Car Fiasco	871
The Northern Society of Electrical Engineers	872
Cost of Electromotive Power in New York and Massachusetts	874
The Electric Lighting of the Blackpool Winter Gardens (*illus.*)	874
The Cost of Laying Electric Light Conduits in Shoreditch	875
The Royal Society Conversazione	876
Correspondence:—Rapid Cable Laying for War Purposes (*illus.*)	876
Sullivan's Method of Determining the Relative Positions and the Top and Bottom Ends of Several Cables in a Tank (*illustrated*)	878
Uninsulated Pipe Wiring	878
Business Notices, &c.	879
The Chicago Edison Company (*illustrated*)	881
Electric Lighting Notes	885
Electric Traction and Motive Power Notes	886
Telegraph and Telephone Notes	886
Contracts Open and Closed	887
Notes	887
City Notes	892
Traffic Receipts	892
Share List of Electrical Companies	893
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*)	894
On the Capacity and Residual Charge of Dielectrics as Affected by Temperature and Time (*illustrated*) (*concluded*)	898
New Patents	900
Abstracts of Published Specifications	900

THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

PRICE 6/- POST FREE. The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1897.

PRICE 6/- POST FREE. Fully Revised and Thoroughly Reliable. Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,

22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGEKKAY, LONDON." Code A B C. Telephone No.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES,—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VENUVE J. BOYVEAU, 29, Rue de la Banque. *Berlin* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

DYNAMOS.

THE paper read by Mr. Mordey on this subject before the Institution of Electrical Engineers, the concluding portion of which we publish this week, is a practical demonstration of the fact that the topic has been very thoroughly exhausted; very little of novelty or great interest to practical dynamo makers is to be found throughout the somewhat lengthy dissertation. It begins with the proposition that there is plenty of scope for saving materials and labour in the designing of dynamos. The various designs for the accomplishment of these desirable objects are all well known except the new winding introduced by the author, the purport of which is to counteract the back turns or magnetic field due to the magnetism of the armature.

Judging from experience with all previous schemes for this same purpose we should think that while the device may show improvement over ordinary winding on a Gramme ring, it is very doubtful if it will accomplish all that its author has aimed at. The question is how much material is saved in the magnets when this winding is applied? The example given and the claim made that it produced one-third more output from a machine with a toothed core compared with a machine with a smooth core, are not to be accepted as conclusive. The test was made on an admittedly bad dynamo; how much the new winding would have improved a good machine is yet problematical. The dimensions of the test machine are unfortunately not stated, else we might have been able to compare machines of similar dimensions with the results of the new winding. At any rate, this 30 per cent. gain requires some confirmation.

That the reaction of the armature of a smooth core type lowers the output by one-third is, if true, somewha startling.

Kapp long ago showed clearly that different types of field magnets required very different amounts of wire, and the internal field magnet has long been recognised as the least in weight for its capacity; yet in this country the bipolar horse-shoe magnet is almost universally used, although it i far from being the most economical form.

As a type, it keeps to the fore, probably more by reason of its being employed successfully and with satisfactory results by many large manufacturers, and installed in places where firs cost is not the sole consideration; still as the great first cos of motors often stands in the way of the adoption of electrical power transmission, there is certainly room for revolutionary designs for machines in which the best use is made of the materials, and all sources of losses which require to be made up by increased weight abolished. Mr. Mordey deserves the thanks of the profession for drawing attention to these points.

The discussion indicates that established manufacturers are slow to depart from their standard designs, the expense in doing so being very heavy, while there is always an element of uncertainty as to the advantages in the new departure; it is therefore, as a rule, to new firms that the introduction of novel designs is left.

If Mr. Mordey's invention does not much reduce the cost of dynamos, it certainly will reduce the sparking difficulties, and this may cheapen indirectly the first cost of machines constructed with the new winding, as it must to some extent reduce the field magnet flux and ampere turns required, as well as reduce the compound winding required in compound machines.

The reduction of sparking at heavy loads is always an important gain, and we sincerely trust that the fears of some of the speakers in the discussion regarding large machines built on this plan, are groundless.

As to the drag on armature conductors embedded in iron, Mr. Mordey's experiment is conclusive enough; but the explanations made to account for the disappearance of the drag in buried conductors, like those made by Mr. Sayers, are only fictions set up to back up the fundamental notion that cutting of lines of force generates the E.M.F. Nobody can say what really does happen, although some people are very dogmatic on the point that the lines snap across the embedded conductors with inconceivable rapidity, thus the conductors virtually pass through a weak field at great velocity, and so on; these theorists are compelled to invent scores of wild assumptions to back up their first conception. However, the important point is that the conductor, if sunk in the iron, is not subjected to drag; that, we should have thought, was beyond question, and the theories which explain the generation of E.M.F. by jumping and snapping of lines across air spaces in preference to slipping through soft iron, may be attacked on other lines; for the purposes of dynamo construction, these theories are of little significance.

On the whole, the paper will be valuable, as it traverses the complete subject of dynamos in a very lucid and popular manner, so that those who have little special knowledge of the matter can with ease acquire a pretty fair idea of the many difficult points of, and interactions in, dynamos.

The discussion was somewhat weak, the speakers seemingly not having fully digested the whole paper. Absolute dryness, however, was relieved by the pleasantries in which one of the critics and the author freely indulged. Possibly we shall hear more about the paper later.

Seismology and Cables.

Prof. Milne's lecture at the Royal Geographical Society last Friday evening, dealt somewhat with the causes that bring about cable interruptions. He accounted for their fracture by supposing a kind of submarine landslip, the giving-way of subaqueous prominences, constituting the general levelling process of the sea bottom. We were to imagine the cable entombed in the *débris*, and strained to its breaking point by the weight of superincumbent matter. Sir Archibald Geikie pointed out, as an objection to such a theory, the difficulty of accounting for the submarine hills. Earthquakes were essentially a *land* phenomena; there was tolerable quiescence at great sea depths. He thought the disruptions might be accounted for by the mere sinking of the cable into the soft ooze. Prof. Milne, on the other hand, exhibited charts showing by actual soundings that great changes of level do occur at sea bottoms during short periods of geological time, strong evidence of the magnitude of the masses of displaced matter, and the consequent heavy stress on cables associated with the action. Owing to a certain burlesque manner of the lecturer, it was not always easy to follow the thread of his argument; but the humour was occasionally relieved by happy flashes of sound statement of fact. As an observer of seismological disturbances, Prof. Milne is at his best, for he is then quite serious. The ostensible object of the lecture was the inauguration of seismological observatories on some universal system. The various advantages to be expected from seismic records, and the usefulness of seismic knowledge to the domain of pure science, were clearly emphasised by Prof. Perry. He was strongly in favour of the scheme; the study of seismology had led to improved design, and greater safety and comfort of dwelling houses in earthquake districts, and there was no doubt a further advantage to be gained in the security of cable systems by a properly organised perpetual record of earth movements. But apart from mere utility, seismic records would be of invaluable aid to science, seismological movements were the only messages received from the extreme earth-depths, and no trouble should be spared in recording and interpreting them. There will probably be found geologists enough to confute Prof. Milne's deductions as to the cause of earthquakes; but they will all agree as to the desirability of making the observations more perfect and more widespread. To us this would seem a matter easily to be attained by co-operation with meteorological observatories at home and abroad. It would scarcely involve an increase of the staff; instruments would not cost a very large amount. Moreover, as cable companies are to be the people to benefit by the scheme, they might be induced to convey messages, associated with the scheme, at a nominal rate. In Italy, unless we are mistaken, State aid is already being given to seismical research; and at Ischia, Signor Grablavitz has, we believe, a very perfect seismological observatory. We hope to give a fuller account of the lecture in our next issue.

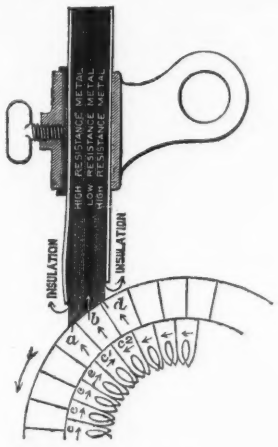
Tramway Operating Expenses.

The question of accounts seems to fill more space in American technical journalism than it does here, probably because there is one association of accountants which pays attention to the question. The *Street Railway Review* publishes several letters from street railway secretaries and auditors upon the question of computation of expenses upon a car-mile basis or a passenger mile basis. One would hardly suppose there could be much difference of opinion, for while passengers are essential to dividend, a line must be worked, and whether there be few or many passengers, will not make much difference to operating expenses. So far then as the cost of power is to be examined into it would be manifestly wrong to praise or condemn the engineers' department on a basis of passenger-miles. Some years ago, when a Mr. Dorsey wrote a paper comparing English and American railroads to the disadvantage of the former, he went so far as to base his discussion of locomotive efficiency on the earnings and compared economy of fuel on a basis of receipts in place of upon tonnage moved, forgetting that the question of locomotive efficiency is one of power only and has nothing to do with receipts. Necessarily certain accounts must be compared on a passenger basis, but in seeking to know if the power department is being worked to best advantage it is obviously absurd to take a money basis. The car-mile is clearly the datum of comparison. Illustrating this, the Columbus Street Railway shows for the month of December in two succeeding years an expense of ·088 and ·095 per car-mile, or a decrease of 7·4 per cent. upon the latter figure, while per passenger the figures are ·024 and ·032, or a decrease of 25 per cent. At the same time one writer points out how a good case may be made out for the operation by running a useless quantity of mileage. It would be easy to run an excess of cars and reduce the item of central station expenses per car mile, so that where this expense is low, and receipts are low, it becomes necessary to enquire how far the car mileage could be reduced without reducing passengers. Another writer points a warning as to affording the outside public information which only an expert can safely use. He advocates a car-day basis for earnings and expenses. Generally the car-mile basis is approved, and in many cases it would seem essential to use this basis for the companies are under legal obligation to run so much car mileage between certain hours and cannot cut below this obligatory minimum no matter what the proportion of passengers.

WESTERN ELECTRIC NON-SPARKING BRUSHES.

On dynamos where metal brushes are required to be used, it is often found necessary to use some means of overcoming any excessive sparking, due either to inherent defects in the machine, or to some other cause not readily removed except by using a better designed generator. The non-sparking brush, recently placed on the market by the Western Electric Company, is designed to prevent sparking at the edge of the brush when leaving the segments, and is constructed with high resistance metal placed upon both sides of a low resistance.

The principle on which these brushes work is shown in the cut taken from our New York namesake. The armature coils are represented diagrammatically at *c c c*, and the brush is shown just before it leaves one of the commutator segments. It will be seen from an inspection of the cut that the current travelling up on either side of the armature, and passing into the brush from the segments *a* and *d*, has to pass through the high resistance metal of the brush, while



the current can pass through the coils c^1 and c^2 into the segment *b*, and from there into the low resistance metal of the brush. Of course, under these conditions, the main body of the current goes through the low resistance metal, and as the segment, *a*, approaches nearer and nearer the tip of the brush the resistance still further increases, and the amount of current flowing from segment, *a*, into the brush is gradually diminished until, just as the brush leaves the segment, there is very little, if any, current to be interrupted, and, consequently, little or no sparking.

This action takes place whether the brush is in its proper position for the load it is carrying or not, the action in the latter case being to reduce the amount of current which has to be broken when the segment leaves the tip of the brush, and, consequently, when sparking does occur, it is not as violent as if the ordinary low resistance brush was used.

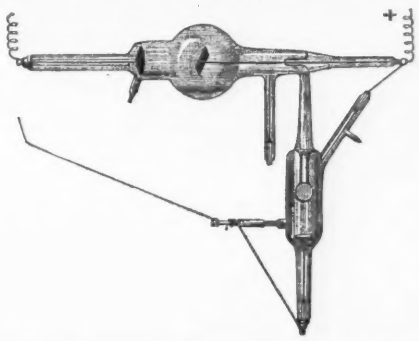
An insulating medium is placed between the high resistance metal and the stiffening springs on the outside of the brushes, which prevents the current from reaching the brush-holder without first passing through the entire length of the brush.

RECENT PROGRESS IN RÖNTGEN PHOTOGRAPHY.

In *Wied. Ann.* for last month (p. 88) is an interesting paper by A. Voller and B. Walter, giving some results derived from a lengthened experience with Röntgen ray work in the State Laboratory at Hamburg.

One of the principal difficulties met with in Röntgen photography has been to get rays from the tube of the exact penetrative power required for the different kinds of work in hand, and to keep the action of the tube constant throughout the exposure. As is well known, the vacuum in the ordinary focus tube tends to increase with long use. As the vacuum increases the penetrative power of the rays increases, and a tube which at first was suitable for taking Röntgen photographs of thin bodies like the hand, will cease to show the required contrast between bones and flesh, though it may become suitable for giving satisfactory exposures of thicker parts of the body. Various devices have been invented to get over this difficulty. Mr. Swinton makes the cathode of his tube adjustable; and Dorn has applied an old idea of Crookes by placing in the tube a small quantity of caustic alkali which when heated gives off sufficient moisture to regulate the vacuum in the tube. It is this method of Dorn's which has been modified by Voller and Walter, and found to give very satisfactory results. The caustic alkali is placed in a small side tube joined on near the anode. A spiral of platinum wire is wound round this tube, and the necessary heat is applied to the caustic alkali by sending a current through this spiral from a battery (3 accumulators). By regulating the heating current, Voller and Walter have succeeded in keeping the vacuum constant within limits corresponding to air sparks of from 1 to 30 cm. It was found necessary in this arrangement to put the anode to earth to prevent sparking to the platinum spiral. It is necessary that the insulation of the induction coil should be very good on account of the doubling of the potential at the cathode.

A still better arrangement for heating the caustic alkali or other absorbent, and automatically regulating the vacuum of the Röntgen tube, has been devised in America by Mr. H. Lyman Sayen. A reference to the illustration will best explain the operation of this device. A small bulb containing a chemical which gives off vapour on being heated and



reabsorbs it when it cools, is directly connected to the main tube and surrounded by an auxiliary tube, which is exhausted to a low vacuum just sufficiently high to generate cathode rays. The surrounding tube is fitted with a cathode disc arranged to discharge cathode rays on the bulb containing the absorbent chemical. The vacuum in the main tube is made so high that the coil is unable to discharge through it.

In operating, the induction coil is connected as usual to the main bulb. On starting the coil, the vacuum of the main tube being high, the resistance is also high, and the current takes the path of least resistance through the auxiliary tube, and thereby heats the chemical in the small bulb. This will continue for a few seconds, until a sufficient amount of vapour has been driven into the main tube to permit the current to go through it. After this only an occasional spark will jump across the spark gap to maintain the tube at the same vacuum. The vacuum may be maintained high or low, by placing the spark point a considerable distance from, or close to, the cathode of the main tube.

In Sayen's tube, the vacuum of the main bulb is fixed and maintained for any length of time by the length of spark gap between the free end of the wire and the cathode terminal. After a little experience the tube may be set to produce Röntgen rays of the exact penetrative power which is best suited for the object to be photographed. Currents of different strengths may be sent through the main tube without altering the vacuum or the penetrative power of the rays emitted. The length of the exposure which depends on the strength of the current can thus be regulated without altering the penetrative power of the rays.

The importance of adjusting the penetrative power of the rays to the object to be photographed is shown by two series of photographs, taken at widely different vacua, and reproduced in Voller and Walter's paper cited above. Some of the substances, which are quite opaque to the rays from the low vacuum tube, are tolerably transparent to those from the high vacuum tube.

Voller and Walter have also made experiments on the relative degrees of diffuse reflection possessed by different elementary substances. They divided the substances into the following five groups, according to their atomic weights, (which are given after each element):—I. Carbon (C=12) as diamond. II. Magnesium (Mg = 24), aluminium (Al = 27), sulphur (S = 32). III. Iron (Fe = 56), nickel (Ni = 59), cobalt (Co = 59), copper (Cu = 63), zinc (Zn = 65), selenium (Se = 79). IV. Palladium (Pd = 106), silver (Ag = 108), cadmium (Cd = 112), tin (Sn = 119), antimony (Sb = 120). V. Iridium (Ir = 193), platinum (Pt = 194), gold (Au = 197), mercury (Hg = 200), lead (Pb = 206), bismuth (Bi = 209).

It was found that the elements of the silver group were the best reflectors. The elements of the copper group were a little inferior, and those of the platinum group very much inferior in reflective power to the silver group. The reflection from the aluminium group could hardly be detected, while no effect at all could be observed with the diamond.

A remarkable feat in Röntgen photography has been accomplished by Dr. W. J. Morton, U.S.A.* He has succeeded in producing a full length Röntgen photograph of an adult, 5 feet 4 inches in height, by a single exposure. Hitherto such full length photographs have been produced by dividing the body into sections, exposing these separately, and then patching the resulting photographs together.

The apparatus employed by Dr. Morton included a 12-inch induction coil, whose primary was supplied from the 117-volt Edison current of the street mains, and "made" and "broken" by means of a break wheel causing about 5,000 breaks per minute. Both condenser and blower were employed to keep down the spark on the break wheel. At a revolution of the break wheel of 5,000 per minute, the coil afforded a free discharge of sparks across a 5-inch air gap, the number of amperes flowing through the primary circuit being 3·6, and the voltage at the terminals of the primary being 75. The tube employed was an ordinary focus tube; its vacuum at the start corresponded to a spark of 2 inches, and gradually rose till at the end it corresponded to 8 inches. The distance of the tube from the sensitive film was 4 feet 6 inches. The tube was run the first 10 minutes steadily; then the current was turned off several times during a minute to cool. The whole time consumed in taking the picture (including stoppages) was 30 minutes.

A sensitive film, 6 feet long × 3 feet in width, supplied by the Eastman Film Company, was used. An attempt was made to use two tubes simultaneously, but this failed because double outlines were produced, and because it was found difficult to work more than one tube from the same coil. The picture was remarkably successful, except that the thicker parts of the trunk were somewhat under-exposed.

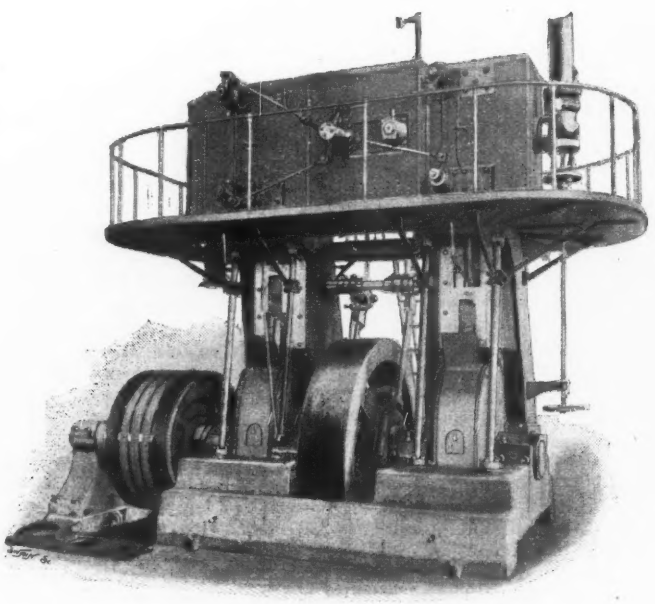
Dr. F. S. Kolle,† in writing on the inflammatory and other harmful effects of the Röntgen rays, considers that they are mostly due to placing the focus tube too near the subject. The blisters produced yield to treatment as readily as similar blisters produced by other causes.

* *Electrical Engineering*, N.Y., May 19th, p. 522.
† *Electrical Engineering*, N.Y., May 19th, p. 521.

VERTICAL COMPOUND ELECTRIC RAILWAY ENGINE.

We illustrate below one of the vertical compound condensing engines which have been designed and built by the Ball & Wood Co., of New York, for La Capital Tramways Company, Ltd., Buenos Aires, Argentina, for running the street railway systems of that city. The cylinders, according to the *Street Railway Journal* from which we have reproduced this illustration, are proportioned for a normal load of 425 H.P., the high pressure cylinder being 14½ ins. in diameter, low pressure 30½ ins. in diameter, stroke 18 ins., and the engine is designed to operate at 175 r.p.m. The valves are of the Corliss pattern and are placed in the cylinder heads, thus short, direct ports are obtained with minimum clearance. The admission valves are controlled by the Ball & Wood governor while the exhaust valves are actuated through adjustable eccentrics.

Engines of this type are stated to have shown remarkable economy when under test.



Vertical Compound Electric Railway Engine.

ELECTRICAL TRANSMISSION OF POWER IN A COLLIERY.

The *Engineer* publishes a translation of a Memoir of the Society of Civil Engineers of France, by a M. Gorchot.

This paper adds but one more convincing argument to the already large mass of evidence pointing to the apparently best function of electricity, namely, as a substitute for belts, shafts, water in pipes under pressure, air or steam. No one of these agents is able to compete with electricity in certain work, and especially in underground work. Belting is ruled out at once. Shafting is still more impossible. Water pressure presents the difficulty of getting rid of the water. Steam has the undesirable fault of temperature, while air is too wasteful for want of heat to help its efficiency.

M. Gorchot describes the electric installation at a colliery raising 5,200 tons daily. The distance between extreme points is nearly 5½ miles, and all power is brought from a surface station which includes a power house, a boiler house, and a gas producer house. The fuel used is dirt and shale separated in the washing and screening. The gas producers are of simple open grate form, 11½ inches square and 7 feet deep. The grate is arranged so that it can be cleaned in sections. There are eight producers in a block, and each serves two boilers of which there are eight.

There will be ten dynamos and two exciters. The dynamos are triphased alternators of Thury's form, with fixed inductor and armature coils, current being generated by the rotation of a toothed steel ring closely surrounding the armature, which has a core of soft iron discs ½ mm. thick with paper insulation and binding bolts of ferro-nickel. This core carries the winding, arranged like a Stanley alternator, there being six coils to one pole on the inductor ring.

The magnetising coils are rings of electrolytic copper

ribbon, hemp insulated and shellac covered and stove dried. These rings are arranged in parallel rows with small air interval.

The toothed ring is 7 feet 4½ inches diameter; it runs at 360 revolutions, and is driven by a three compound Willans engines coupled to the ring by two discs with pins projecting from their faces at different radial distances, the dynamo disc being the smaller. A thick band of leather passes over and under the opposing pins alternately, and an elastic and insulated coupling results. These 10 machines are to be arranged in two parallel rows, each with its exciter of 50,000 watts, to supply both exciting and lighting currents, the former only calling for 36 of the 2,400 H.P., so that only one exciter is used, the other being reserve. The generator foundations are completely insulated from the floor, which is raised 10 feet above ground. The high tension currents are carried to the switchboard in a vitrified brick conduit, no conductor with more than 110 volts being exposed.

One group of mines 3 6 miles distant is supplied with current by three copper wires of 4½ mm. diameter, capable of transmitting 600 H.P. with a loss of under 5 per cent.

300 H.P. is taken off on the route, and 300 transmitted full distance. The three wires are carried on isosceles triangles fixed at the top of 33-feet wood posts, 98½ feet apart, and wound with a double spiral of barbed wire and with a ring of barbed spikes placed 20 inches below the lowest conductor.

Cables replace these naked conductors at bridges and places of much traffic. Double bell porcelain insulators are used. The transformer house, of vitrified brick in cement, contains two multiple core Schuckert transformers of 100 k.w. each, reducing the voltage from 5,000 to 750. When the door of this room is opened, the transformers are put automatically out of action. Nothing can thus be touched when current is passing. The pit cable is formed of stranded conductors of tinned copper wire, especially insulated and waterproofed, and secured to the wall by wooden jawed clamps at 20 metres intervals. M. Gorchot thinks it safe to use current of 750 volts underground, with reasonable care of the insulation.

Long wall working is practised. Jeffrey coal cutting machines are used. They require 15 H.P., and absorb, when starting light, 2,500 watts; when beginning the cut, 8,000 watts; full cut, 11,000 watts; return stroke, 5,000 watts, an average of 0·24 H.P.-hour, a cut of 3¼ inches by 6 feet deep by 39 inches long being done in 4 minutes.

There are also spirals drills, at 500 revolutions, driven by 3 H.P. motors at 1,800 revolutions. A 5-foot hole is bored in less than a minute.

Haulage engines are of two kinds, one of 25 H.P. at 320 revolutions on the inclined planes, lowering coal from the workings to the main road, and two larger ones of 40 H.P., working haulage to the shaft. The motors are of Dolivo Dobrowolski pattern, and give 90 per cent. efficiency on full load. Trains weigh 20 tons, and are hauled at a speed of 6½ miles per hour. In the up-cast is a Mortier fan of 34,000 to 38,000 cubic feet capacity per minute, with a 25 H.P. motor on its axle. It makes 320 turns per minute. There are several smaller fans of 3 to 7 H.P. A 50 H.P. motor replaces the compressed air driven duplex Worthington pumps. The present pump forces the water of drainage at one lift 1,100 feet up the down-cast shaft to the surface.

In this one group there are in all 285 H.P. of motors, but not more than 150 H.P. is in use at once. The output is 600 tons per shift, and there are other four groups of 400, 1,250, 1,400, and 1,600 tons capacity similarly provided with electric power. In one of these a water feeder at 1,640 feet deep gives 530,000 gallons per day. This water is all dealt with by two pumps of 250 H.P. each. One of these could do the work continuously. The two together do it all in the night shift, when coal cutting and hauling is stopped. The motors for these powerful pumps are driven by current of the full 5,000 volts, and they are provided with their own circuit from the central station on account of the importance of their duty. Apart from the various mines, some current is used in driving small looms and knitters in the homes of the workpeople to provide occupation for the women and girls who are not now employed at the pit head at the unfeminine work of picking coal. At each group of dwellings current is reduced from the mains at 60 volts, and connections are made in sealed boxes to prevent use of current other than as intended. Two classes of motor are employed; one drives by belt from above, the other from below the machine by screw gears, and while considered safe is scarcely so efficient. The motors are ¼ to ⅓ H.P., and run 2,000 or 2,400 revolutions on the screw gearing and half the speed when belted, and they give 50 to 65 per cent. efficiency. The total expense of staff, which includes one foreman and four assistant electricians, four enginemen, two labourers, sixteen firemen, four assistants, four ash wheelers, and two horses, is 51,240 francs annually, or say £2,000, with 3,610 frs. for oil, waste, and lighting. The plant cost £36,600 complete from chimney to electrical fittings. Sinking fund and depreciation, working cost, and maintenance charges amount to £3,330. The fuel has no commercial value, but is charged barely £1,000 per annum.

The total annual expenditure, including sinking fund, is 161,150 francs (£6,446) and the average output is over 1,500 I.H.P., or 1,260 at the switchboard, equal for 365 days of 24 hours to 0·16d. per H.P. hour.

The following efficiencies are given:—

Engines at full load	91	per cent.
Alternators	93	,,
100 kw. transformers	96	,,
250 H.P. motors	92	,,
60 ,, ,, ...	90	,,
25 ,, ,, ...	87	,,
6 ,, ,, ...	80	,,
3 ,, ,, ...	75	,,
½ ,, ,, ...	65	,,

Hence the following useful effects from boiler to water lifters:—

Engine	91	per cent.
Attention	84·03	,,
Line	82·12	,,
Pump motor	75·53	,,
Gearing	71·70	,,
Pumps	50·2	,,

The line being allowed 97 per cent. efficiency.

In the days of compressed air, used without auxiliary heating, the maximum effort realised was 16 to 20 per cent. only. The importance of the saving, if fuel had been of ordinary cost, is evident.

REVIEWS.

The Materials of Construction. By J. B. Johnson. New York: John Wiley & Sons, 1897.

This handsome volume is but another of many very excellent technical works by American engineers. To what we are to attribute the great development of the literary side of engineering we cannot say. It was wont to be said that America produced no poets because Americans had not time to attend to such light trifling, and generally that the element of books was not one that suited Americans as producers. Things have changed and American technical works have secured for themselves a recognised and high place. Prof. Johnson has written his book to English units, preferring to do so than to use the metrical system.

The value of any book of this kind depends of course entirely upon the manner in which its author has compiled it, for obviously such a book must partake very largely of the nature of a compilation. As the author very truly remarks, the practising engineer cannot to-day assimilate the mass of information constantly accumulating in regard to the strength of materials; he is bound to take much for granted, and a very heavy responsibility rests upon an author like Mr. Johnson when he puts out to the world a book on strengths of material. Engineers must trust to the tests made for them by others, and therefore when they take a compiler's figures it is desirable that such figures shall be true. It is to present such figures that the author has aimed and obviously one must take such figures very much on trust.

One cannot well review a work of this kind in detail. We may turn to special parts and consider the figures there present on subjects more familiar to us than others, and by their accuracy form an idea of the accuracy probably occurring throughout. One good feature is the comparative absence of tables, which have been replaced by graphic diagrams so as better to show relationships.

The value of diagrams depends entirely upon their intelligent plotting, but when plotted, to use the author's term,

"to significant arguments they at once convey meanings that cannot easily be unearthed from columns of figures." The author's close connection with the very excellent work being done by the Forestry Division of the U.S. Government has enabled him to write very fully on American timbers, which are also numerously illustrated, not merely in foliage, but also in an attempt to give a representation of the wood itself, and the same with cells magnified.

This section on timber is naturally very copious, and in view of the large importation of American timbers to this country, it should be equally valuable to us as to the Americans. In the past there has been a far less amount of attention paid to the physical properties of timber than its standing as a material of construction fairly warrants. This want of attention to timber has prevented a knowledge of much valuable material. Take, for example, the Kauri pine of New Zealand. Anyone who has used this, who has worked it, and who knows how one may buy the run of the market and not find a knot in a wagon load, is astonished at the ignorance which prevails in this country as to the very existence of this timber

Then, again, the Rimu, the Matai, or the Australian blue gum, Tallow wood, and Black Butt are all timbers that should be known at home, besides many others we have used in the Colonies. In his treatment of timber our author, though good, is narrow in the sense that he confines what he has to say to the timbers of America. America has, of course, an immense variety of timber, yet nothing comparable to the woods of the Southern Hemisphere for particular purposes. They are, indeed, *sui generis*.

Considering the importance of the cement trade, one turns naturally to the section on cement. Cement is used very much in America, and huge slices of the cliffs along the Thames estuary have gone into American bridge piers. There was a time when the English cement makers waxed fat and careless, and German makers came along, and by very fine grinding over-balanced the superior excellence of the English raw material which cannot be surpassed. The Germans took a lot of the Pacific Coast trade from us, but now the English makers can grind finer than the Germans, and they have got back their lost trade. American engineers have had great influence on the cement trade, because the American specifications called for certain properties that no simple combination of lime, silica and alumina could possess. The Germans, however, found out that a small percentage of gypsum had the effect required to make the cement fill the American specifications. Now gypsum is not a desirable element in Portland cement, because it tends to produce unsoundness. Thus American engineers are responsible for much dangerous cement, and it is important that such adulterations should be carefully watched, especially as much the same effect can be got by more legitimate means. We fail to find any appreciation of this bad effect of American specifications in the book. This is to be regretted, for we much fear that many failures of cement work in the future will be found traceable to this pernicious German adulteration.

The extreme parsimony of American engineers in respect of the use of steel in bridgework which has been brought about by the necessity of long span bridges of cheap construction has had one good result in compelling close attention to stresses, and has made of many bridges huge examples of the (not always too) gradual failure of parts when exposed to excess of stress. Hence the testing of structural steel has been closely attended to by Americans, and we find consequently that our author has devoted very much care and space to this important subject. He almost apologises for an innovation proposed in regard to the elastic limit. Every engineer has his idea of the limit of elasticity. There is no law for it. It varies with the hardness of steel, and while great ductility may be a virtue, it is more or less balanced by low elastic limit. Now it is proposed that the elastic limit shall be fixed at that point in the stress diagram where the rate of deformation is 50 per cent. greater than it was at the origin. There seems a certain reasonableness in the suggestion, though it savours somewhat of the habit contracted by many voluminous writers of propounding theories in place of recording facts, so that every fresh writer becomes a centre of some new contagion, and we get the gospel according to Johnson, or Kennedy, or Thomas Atkins, whereas we want only texts on which to fashion our own sermons. We don't say this to pull down the credit of which Mr. Johnson's work is so well deserving. It is likely to become a standard work of reference and is as good as its material get up, which it is enough to say is fully up to Messrs. Wiley's standard of excellence.

The Engineers Sketch Book of Mechanical Movements. By Thos. Walter Barber. Third edition. London: E. & F. N. Spon. 1897.

This well known book has been very considerably enlarged and extended in scope. It now contains 2,603 illustrated movements or devices. These are collected under various heads for better reference, and each has a line or two of description sometimes merely the name when self-explanatory. No attempt at detail is given. The devices are crudely illustrated only as an aid to the designer in scheming out movements, but the illustrations are quite sufficient for their purpose, and the collection is valuable and useful. It is, indeed, not confined strictly to movements.

Certain tools, for example, are illustrated, also jets, nozzles, and injectors, journals, bearings, and pivots, and, in fact, the thousand and one things which it is the engineer's business to incoporate in his plans and to modify to suit his purpose. There are so few orginal devices now possible, that is, original in their entirety, that it is useless attempting to think out new ones entirely for the sake of novelty if some other tried device will serve. It is probably only on rare occasions that some sketch in this book will not furnish a design, or at least suggest ideas.

THE INSTITUTION OF CIVIL ENGINEERS.

(*Continued from page* 796.)

"THE DECIMAL SYSTEM IN ENGINEERING MEASUREMENT."*

By Henry Riall Sankey, Capt. R.E. (ret.), M.Inst.C.E.

Broadly speaking, the decimal system is used in engineering in this country whenever calculations other than mere checking have to be made, or when very accurate dimensions have to be expressed; and in either case, in mechanical engineering, the decimals are generally those of the inch, its square, or its cube. The reason of this is fairly obvious. As regards calculations, decimals are, on the whole, far simpler than vulgar fractions, and they allow of the ready use of the slide rule or tables of logarithms.

It is true that occasionally simple vulgar fractions have to be dealt with, as, for instance, $\frac{1}{8}$th in the case of the formula for the strength of a rectangular beam. In such cases the vulgar fraction would obviously be used; to convert to decimals would correspond to using a slide rule or a book of logarithms to multiply 6 by 5, or some such simple sum.

In the case of accurate dimensions in mechanical engineering, $\frac{1}{64}$th inch is far from being a sufficiently small dimension; hence the use of the terms bare and full, and as, for interchangeable work, such vague dimensions are very unsuitable, recourse is naturally had to the use of $\frac{1}{100}$th inch and $\frac{1}{1000}$th inch. The writing down of accurate dimensions is also very cumbrous even when they can be expressed by $\frac{1}{64}$th inch.

Compare, for instance, 11 inches + $\frac{1}{16}$ + $\frac{1}{32}$ + $\frac{1}{64}$ bare with its decimal equivalent 11·98 inches. No doubt the same dimension may be more briefly expressed as $11\frac{63}{64}$ inches, but this form is not generally used in practice, and there are obvious reasons why this should be so.

It will be observed that the decimal expression has only been carried to the second place, and this is because the uncertainty in $\frac{1}{64}$th inch "bare" is of the order of $\frac{1}{100}$th inch. If the decimal expression is extended to the third place, an order of accuracy is reached, expressed by $\frac{1}{1024}$th inch on the binary scale, fractions which are not practically workable.

When dimensions of no special accuracy have to be stated, the natural tendency to successively divide the unit by two gains the upper hand. Notwithstanding this tendency and the prevailing custom, it can scarcely be doubted that it would be preferable to state all such dimensions in decimals of an inch.

If decimals of an inch are adopted, the system is still incomplete, owing to there being 12 inches to the foot, 3 feet to a yard, and so on.

It is here that the metric system has a great advantage—it is a decimal system throughout. As experience in such a matter has more value than mere theory, a statement of the results of introducing the metric system of linear measurements into the works of Messrs. Willans and Robinson may be of interest.

---

* Read May 27th, 1897.

In the first place it is desirable to say a few words about the class of work and method of manufacture carried out at the works in question.

The Willans central-valve engine and the Niclausse water-tube boiler are manufactured each in certain definite standard sizes, and the parts required are made to gauge and template in large batches, and have to conform to fixed dimensions within specified limits of accuracy, in order that strict adherence to the interchangeable system may be maintained.

In the machining and examination of the parts, gauges and templates are used, as far as possible, to the exclusion of the measuring rule. Whether inches or millimetres are used is therefore not a matter of much importance.

At the marking-off table the measuring rule is, of course, more used, and the question of convenience in the unit of measurement, and its divisions, is of greater importance; the parts are, however, dealt with in batches, and the convenience or otherwise of the unit of measurement, and its divisions, tells once, only, for each dimension for the whole batch.

The circumstances that led to the adoption of metric linear measurements are not of general interest, and for reasons which need not be entered into here, they were only applied to the Niclausse boiler, and to certain sizes of the engine. The earlier sizes being still made to drawings figured in feet and inches; thus the two systems are concurrently at work in the same shop.

There would have been no advantage in re-figuring these drawings with equivalent millimetres, and to make new parts to millimetres to interchange with old parts made to inches would be impossible without going to several places of decimals. The old gauges and templates were marked with the millimetre equivalent to the third place of decimals, but this was merely to accustom the men to sizes expressed in the new system. It may be mentioned that the men were supplied with rules marked with millimetres on one side and inches on the other.

The expense involved consisted principally in providing a complete set of gauges. New templates and jigs had also to be made, but only a portion of their cost is properly chargeable to the introduction of the new unit, as the greater number of them would have been required in any case.

The only difficulty met with has been in connection with the screw threads. Hitherto the ordinary Whitworth and gas threads have been retained; but, for reasons connected with the manufacture of the engines abroad, the body of the bolt or stud is turned larger than usual, the excess being 0·3 millimetre for ½-inch Whitworth, and 2 millimetres for 1¼-inch Whitworth; intermediate sizes are in proportion, all being brought up to even millimetres. The bored holes are then able to take the corresponding screw cut to the standard used by the French makers of the engine, who use the thread of the Société d'Encouragement, which is slightly larger than the Whitworth, and which, it is stated, promises to become universal in France; it is now adopted by the French navy and railways.

The metric dimensions were introduced in May, 1893, and after four years' working, the following is the result:—

No difficulty has been experienced in getting draughtsmen to use the new measures. No serious mistakes have been traceable to the change, and very few minor ones. The draughtsmen are practically unanimous in favour of metric measures, finding it easier to design, to check, and to read millimetre drawings. Taking all fractions into account, little more than half the number of figures formerly used are now required to express a dimension. An average case would be 3 feet 1⅜ inch, which, on a millimetre drawing, would be figured 949; and an extreme, though possible, case is 3 feet $1\frac{3}{32} + \frac{1}{64}$ inch bare, which becomes 942·4.

The need to use decimals of a millimetre is very infrequent, but in the case of inches the use of fractions is, of course, the rule. A cylinder, for example, might be figured 2 feet 6 inches on an inch drawing, and 770 on a millimetre drawing; the piston body must have a certain clearance, say, $\frac{1}{32}$nd inch in one case, or 1 millimetre in the other, in which case it must be figured 2 feet $5\frac{1}{8}$ inches on the inch drawing, whereas on the millimetre drawing the dimension becomes simply 768, and the use of fractions is wholly avoided.

The proportions between dimensions are more readily appreciated when expressed in millimetres; thus the ratio between 27 millimetres and 49 millimetres is much more easily apprehended than between $1\frac{1}{16}$th inch and $1\frac{29}{32}$th inch.

A point of some importance is that the ordinary foot and inch ticks or marks are not required, and with them disappears the possibility of having 2 inches added to each 10, or deducted from each foot in a dimension. A case of this kind occurred in which two 13-inch flanges intended to come together were shown on different drawings; in one of them a tick was introduced after the one, and that flange was made 1 foot 3 inches.

With millimetres a cipher might possibly be put in, or omitted; but a dimension 10 times too big or too small would at once be noticed as absurd.

In the drawings, scales 1, ½, ¼, $\frac{1}{10}$, and occasionally of $\frac{1}{25}$, $\frac{1}{50}$ are used. It is found that this number of scales is amply sufficient.

No mistakes have been made in marking off work to millimetres. The men preferred the old system at first, the new figures conveying little idea of size; but they are now much in favour of the millimetre, and find drawings so figured easier to read. The shop where the difficulties of the change would be most felt is that in which the tools and gauges are made; the foreman says that it was a little awkward at the outset—for about two days.

In the work's manager's opinion, the metric system would prove even more advantageous in shops where measurements are taken from the rule than where gauges are used. He considers it easier to teach men the use of the rule with the metric than with English measures.

THE MOTOR CAR FIASCO.

Now that the *Engineer* competition is over our contemporary's columns are being filled with the very natural protest consequent upon the remarks as to the absolute non-existence of a motor-car industry in England. The Daimler Company contradict this flatly, and state they are making three cars weekly, and have 200 men employed. The *Engineer* gibes at 200 men turning out but three cars per week, and the wage account can scarcely be termed moderate. But, perhaps, the *Engineer* never helped to start a new business? Those who have done so will easily understand that the wage account does total up in a most unaccountable manner. Even the people from whom you buy stores look on you as fair prey to be pillaged, and the difficulty in getting around one a suitable and satisfactory set of men is, at times, most disheartening. We by no means consider that the *Engineer* is fair even though the motor car industry be very small.

The *Engineer* repeats its assertion that light oil vehicles were admitted, and upon very liberal lines. Mr. Moore, of the Motor Car Club, however, quotes the *Engineer* itself:—"In the first instance we excluded vehicles propelled by light oil or petroleum spirit," and there seems to be little doubt that these vehicles were excluded from the competition. Mr. Moore also objects to the demand for six sets of drawings of each machine. There were only three judges and six sets of drawings was obviously a big demand. For whose use were they required? Our contemporary finds fault with Mr. Sturney when he claims that the Daimler Company's working drawings have cost them thousands of pounds. They might soon cost that if many sets of six were required. Mr Sturney distinctly states that the Daimler Company are full of orders, have vans working in London, several carriages in Scotland, a van in Manchester, and some 20 in all in the hands of the public and all giving satisfaction, The *Engineer* continues to rail at the Daimler Company, especially as regards a turnover at the rate of £50,000 per annum. Now, is this fair? If the Daimler Company is turning over this much already it is not doing so very badly. There may be no motor car industry, but to refuse cognisance to the at present biggest portion of the industry, and then deny the existence of the industry is not right. If the competition arranged by the *Engineer* had been more liberally framed so as to have given no substantial peg on which to hang any complaint of unfairness, we think it would have been of far more use to the public. If light oil vehicles are not suitable, let this fact be plainly made evident. But to rule them out without a chance, and put them on only in a side show is to beg the whole question, and leave the door open for any Motor Car Club man to complain. The spirit-driven car is not a sweet machine. It vibrates badly when not running, and, as made in France, is open to much criticism as to workmanship. It may, and sometimes does, blaze up, and make itself a nuisance, just as horses do when they fall down and kick and plunge on the ground. But the spirit-driven car can run miles and miles on end with a small quantity of fluid and a little fresh cooling water to replenish its tanks. In these respects it is a success. A commercial traveller in Surrey, Kent, and Sussex, who possessed a motor car of this type could save many hours of valuable time as compared with South country railroads, both in actual time on the road and in weary hours of waiting for the slow trains at long intervals. We do not care two pins for the company promoters who have seriously damaged the motor car industry, but we do wish to see the light oil car get a fair trial. Once get motor cars of any type into commercial use and the way is paved for other cars. It would be satisfactory to see the spirit car helping the electric accumulator car to charge up at night, and there is no reason why it should not do so. We observe that *Engineering* follows the *Engineer* in all its criticisms, and denies equally the existence of a motor car industry, and echoes its quondam bitter enemy to the tune that there is no thoroughly satisfactory self-propelled vehicle. If it comes to this, there is no thoroughly satisfactory horse, and the possession of a horse and the driving thereof are not unmixed blessings. To many people even the smell of a few hundred motor cars would be less unpleasant and far less unhealthy than the effluvium due to horses especially on wooden pavement in a hot city. Yet horses have been bred for man's use for thousands of years and have not been cured of their habits. The motor car is ordered to be thoroughly satisfactory from the start. It has not yet had time to purge itself of the taint of the promoter, and the present poor condition of the industry has arisen because of the promoter and his burdens. Our contemporary, the *Engineer*, surely cannot forget that it was made to figure as supporting the most blatant of many very curious productions of the prospectus order. *Engineering* backs its opinion by reference to the competition at Crewe under the auspices of the Royal Agricultural Society.

Here again only three entries were made and but one vehicle turned up. We have no particulars of the conditions in this latter case and cannot say whether there is as good an excuse in this as in the *Engineer* competition for non-competition. We repeat, however, that if the new industry is worth fostering there must be some liberal allowances made at the beginning. Instead, *Engineering* hints at tramcars carrying their own motive power without nuisance to passengers or to the public as though at present horse traction were of this type, Now we do not hesitate to say that the exhaust of a spirit engine, or even of a heavy oil engine, when in order, is preferable to the wastes of an animal. Moreover, the one is merely transitory and dissipated with no further results; the other remains a nuisance, has to be removed at some expense, and what remains to be dried and scattered by the wind is a disgusting irritant to the eyes and lungs that no self-respecting community would tolerate if it could help doing so.

We could wish that our contemporaries had spoken out more strongly when company promoters were asking the public for money to float their numerous companies. It is the promoters who have done so much to throw back the industry, just as the electrical industry was ruined at the commencement by similar over capitalised promotions. Compare these journalistic Cassandras with the sensible letter of Mr. J. S. V. Bickford in the *Engineer*. He outlines his suggestions for a motor that could be run by anyone. Briefly, these are a boiler of the instantaneous generator type (Serpollet), an automatic water supply and furnace temperature regulator; petroleum fuel, which requires no stoking, and is capable of great range of power; engines, probably single acting, in a closed oil box capable of being cleaned with a stable hose, one tappet admission valve to H.P. cylinder, cranks at 180° and exhaust direct to L.P. cylinder; possibly also an air jet condenser, the exhaust steam carrying in air to the condensing chamber. He reminds us too, that, sooner or later, some horse-pond is certain to be used as a source of water, and boiler designers must bear this in mind. Finally he says that as a maker of petroleum burners, he knows that some of the best firms in England are working on the motor car problem. This one letter is worth something.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Discussion on The Transmission of Power in Factories by Electricity. By S. V. Clirehugh, May 17th, 1897.

Mr. E. W. Cowan said: He would not keep them long, because there were many visitors there, and it would be very much more interesting to hear them than to listen to a voice which was unfortunately heard too often in that room. To begin at the end of the paper, Mr. Clirehugh gave the dynamo losses in his table, and the motor losses at 5 per cent. He did not believe that any dynamo had been built which would give an efficiency of 95 per cent., except on continuous runs at full load, and then it must be a very good dynamo indeed and very well designed. In practice the generator could not work at full load, but at the best must work at an average of 70 or 80 per cent. full load. As to the motor losses, he could not understand why Mr. Clirehugh imagined that these motors gave an efficiency of 95 per cent., and the only conclusion that he could come to was that he misunderstood the purport of that little table. If he had said 15 per cent., he would think he was putting it on the favourable side, considering all the starting and stopping and the low load at which he presumed those machines had often to run. On the subject of first cost, they came to a very serious question, a question which concerned, he thought, manufacturers and consulting engineers alike. The first cost was much too high, and it certainly concerned them to reduce that cost if they possibly could, consulting engineers by avoiding putting in their specification clauses which unduly limited the temperature rise; they should give a fair margin to manufacturers to work upon, and allow them to tender for motors which might be efficient and satisfactory in their work in every respect, sparkless and durable, and yet rise to a comparatively high temperature. Further he found that the controlling arrangements and the gearing amounted in the second table to £60, whereas the motor cost only £69. He thought they should pay very close attention to this subject, they must reduce the first cost of the electrical plant. It was not so much the engine and dynamo, but in the motors and their switching gear, where they must reduce the cost if they hoped to get hold of the very large business which was to be got hold of not only in Lancashire, but all over the country. On the subject of gearing, he was surprised that the worm and worm-wheel was spoken of as being in bad favour. He was under the impression that it had been recognised for some time that in connection with motor work, especially with lifts and cranes, the worm-wheel was, when well-designed and well made, an efficient apparatus; but, unfortunately, it was a very expensive one.

Mr. W. A. Chamen said he came there as a visitor to hear Mr. Clirehugh's paper, with which he was very pleased, and to hear the discussion on it. He did not know that he could give any information which would be of any great interest. His experience with worm gearing had been most disappointing, and he had not seen anything to give the results which Mr. Clirehugh gave in his paper. He would like to point out that when used in cranes or hoists they had the most favourable conditions for worm gearing, because the direction of thrust was always altering, and they could not possibly get continuous runs; but in continuous drives, such as with pumps, it was very far from satisfactory. Up to the present, if they went to all the makers, they would not get one of them to guarantee an efficiency, and a great many would refuse to make worm gearing at all. Mr. Clirehugh made some remarks about the plant being capable of continuous running, and not requiring duplicating. There was a good deal in what he said, but he had been into places driven by such steam engines, and found the poor engineer almost tearing his hair because it was impossible to do even the most necessary and trifling repairs, and the engine was obliged to go on ripping itself to pieces until one day it was obliged to be stopped, and the whole place stopped also. He did not know that he should suggest that the plant should be in duplicate, but he thought there should be a sub-division. They all knew that it was the engine that required the stoppage, and not the dynamo. There was another point of Mr. Clirehugh's about the motors running from no load to 30 per cent. overload, without moving the brushes. That was a very interesting statement, but he had not seen anything like it up to the present, unless it was a motor with Sayers winding. He believed that was very satisfactory. With regard to carbon brushes, Mr. Clirehugh had already done away with his objection to the views expressed in the paper by making a reservation in favour of carbon for use on motors which had to be reversed. He did think also, from some years' experience, that carbon brushes would be found to be more suitable than metal brushes in many cases, because they did not require lubrication. Mr. Clirehugh spoke of having brushes running for six months; but he presumed some attention had been given to the commutators, and that some grease had been put on them. Of course, with the carbon brushes, the carbon dust itself formed its own lubrication. Mr. Cowan had dealt with the points about the motor losses and cost of switch gear, and he agreed with him; but he would like to say that a great many people were complaining that the motors were all right, but that the switching gear was giving them trouble. Something like the sample in the room would probably be all right. Switches with a very large number of contacts worked well, but were expensive, and if made with a smaller number of contacts, keeping the total value of the controlling distance the same, sparking was set up at the edges of the contacts, which soon ruined the switch. To get over this, an arrangement was introduced by his firm by which this spark between contacts was carried to another place where it could be dealt with by means of easily renewable sparking pieces. He had a transmission job in hand (concentric wiring) which might be interesting; it was in London, and had nothing to do with a textile factory. The steam generator was to give 160 horse-power, and the motors would drive all kinds of machinery, such as millstones for grinding white lead, fitters' shop tools, centrifugal pump, two blowers for blast furnaces. That would be a job which would give some interesting figures when completed. In that case he had arranged to use concentric wiring with the outer conductor earthed, although he had had some little discussion with the representative of the fire insurance office about it. He thought it was a better arrangement than that suggested by Mr. Clirehugh, as in his opinion it would be more permanent. He did not like wires stretched up unless they could be bare wires, which, however, could not always be used. He thought that concentric wiring with the outer conductor earthed would last a great deal longer than ordinary cables, and he doubted whether it would cost very much more in the first instance.

Mr. L. B. Atkinson said he thought that the society was fortunate in getting such a practical paper, and in making some few remarks he intended to confine himself to a few practical points, for which reason he would take them as they occurred in the paper. The author referred to the question of governing by means of automatic shaft governors. Governors were like a very great many other things, a matter of fashion, and he noticed that fashion was rather setting against shaft governors. He considered this was due so far as it had a reason to their generally being used to operate free moving valve motions which were badly packed and had a large amount of steam leakage. In the same paragraph, with regard to the ejector condenser, there was a little difficulty occurring in some cases which might, however, occur with any class of condenser, which was worked only when the engine was running. The engine must be capable of working at full power without the condenser; but in a case he was interested in, the engine was driving a pump and using the water that was pumped for the condenser, and before the condenser got the water the engine was not powerful enough to pump the water, and thus the engine would not work and they could not get any water at all. He quite agreed with Mr. Clirehugh in regard to the great difficulty that occurred in finding out the power that was ordinarily required: this difficulty did not only occur in factories and mills, but in collieries and mining work, and it arose from the fact that if they were able to pin the people down to horse power at all they were generally talking about the nominal horse power, the result was they knew nothing of what they had to deal with. He had a case of some machinery provided for abroad; the consulting engineers took care to bind the contractors down, and to test the machine before it went out, but when it got there it was found to be only about half the power that was required, because the purchaser had dealt with and specified the nominal horse-power of the engine previously used to drive the machinery. It was always well to find out what kind of horse-power was referred to with regard to the worm gear, as Mr. Clirehugh referred to that appendix in Unwin's book as to the better design of worm gear, he would like to make a few remarks, but he thought there was a gentleman (Mr. Holroyd Smith) there who could give them more information respecting worm gear than he could. In 1889 he designed some worm gear in accordance with the principles laid down in Unwin's appendix with very good results; he could not recollect the actual figures, but nevertheless he thought that Mr. Clirehugh had over-rated the efficiency that was obtained with worm gear. In some worm gears which they tested at Messrs. Easton, Anderson & Goolden's works some time ago, after running about a fortnight, so that they would have settled to their permanent condition (they were about 6 or 7 horse-power), the reduction being from 700 revolutions per minute to 40 revolutions per minute, and the whole being enclosed in oil bath; the actual relation between the electrical power delivered and the power received on the slow motion shaft as measured with a brake was about 71 per cent. There was thus 29 per cent. which disappeared, but even at that he thought the result was a good one; it was better than was expected. The specification gave 65 per cent. Another point, difficulty occurred with worm gear when they got the larger powers, say, over 15 H.P., with regard to the ball bearing thrust, and he thought it was a great mistake to use them. They could not get all the balls of one size, and consequently the whole weight was thrown on, say, three balls. However, he hoped a little later on Mr. Smith would give them more information on the question of worm gear. With regard to the table on page 3 regarding the relative efficiencies of belt driven and worm driven machines, he might be comparing the wrong columns, or it might be that his arithmetic was at fault; but comparing the E.H.P.

hours in the worm-driven case with the E.H.P. hours in the belt-driven case, he could not help thinking that the superiority of the belt over the worm gear was incorrectly given. It appeared to him that the first case should be about 4 per cent., and the other case less than that. With regard to carbon brushes on page 4, ordinary speaking, his own rule was that for any motor with carbon brushes, and for which *carbon brushes were going to be used to keep sparking down*, they must decrease the load by about 10 per cent., compared to the load with copper brushes. The reason that the carbon brushes were of use was that the energy which with copper brushes appeared as a spark, was with a carbon brush dissipated in the resistance of the carbon, or of the contact with the commutator. With a carbon brush there was a considerable amount of resistance at the contact, but when the carbon brush was used, the commutator could be kept in better order. It had no advantage from the point of efficiency. They would find that with ordinary carbons, if they used about 35 amperes per square inch, a fall of pressure of about 1 volt between the commutator and the brush. This fall of pressure with 100 volts was 1 per cent., and with 200 volts was ½ per cent., and since carbon brushes, even if they run perfectly sparklessly, are often on the position where ordinary brushes would spark, and therefore there was the same loss of efficiency through heating, which was the trouble with them. If they used high conductivity carbon brushes, then so far as the suppression of sparking was concerned, the result was lost, and they came back to where they were with copper brushes. The author stated "that one secret of success and economy in electric power installations was to consider very carefully the machine they had to drive, and to spend a long time in its company." Everybody would agree with that. Some time ago he was asked to provide a motor to give a certain amount of power, and with it a switch, which would enable it to be started and stopped in either direction. He did not know what the motor was to be used for, nor did he inquire, as there were other electrical engineers engaged on the matter, but very shortly after they had got it they started grumbling. They stated that the shaft was bent, and that the switch was burnt out. He found the motor was being used to screw down the setting rolls of a rolling mill, and it was started, stopped and reversed about six times a minute, and they generally reversed it when running at full speed to stop it, with a result that they might easily imagine. The proper way would have been to keep the motor running continuously, and to throw clutches in and out. Coming to the table of efficiencies of power transmission, he did feel with Mr. Cowan that the table was a little overrated. Granting that the dynamo would give 95 per cent. efficiency, he thought 5 per cent. for the motor losses was altogether out of the question for any motor such as was likely to be used in such instances as they were discussing. He thought, however, that 8 per cent. was a full allowance for gearing losses, except with worm gear. An ordinary motor, which would give an average of 85 per cent. efficiency, was a very good machine. He thought the paper was a very interesting one, and he was very glad to have heard it.

Mr. M. HOLROYD SMITH said he had not the slightest intention of speaking until he was called upon, but after his name had been mentioned he could not very well refuse. It gave him great pleasure to be at the meeting once more, and a greater satisfaction to find that their numbers had been increased. Looking broadly upon the question of the paper, he thought it was a question of producing power with a large engine, or with a number of small ones. He did not think it was fair to compare the cost of, say, a 10-horse-power gas engine, and a 10-horse-power electric motor when the energy was supplied from a large generating station. This is simply a question of economics in the production and distribution of power. He was afraid that he could not give them much information on worm gearing without the aid of diagrams; it would require a somewhat lengthy paper to deal with so involved and interesting a subject. He was pleased to hear from Mr. Atkinson that certain worm gear with an electric motor driving it had given a combined efficiency of 71 per cent., because he was responsible for the design of the gear, which had to work under exceptionally difficult circumstances, and he did not expect, nor had he been prepared to guarantee anything higher than 63 per cent. It was therefore a bit of pleasant news to him. He quoted the case of a worm gear some 15 H.P., with a reduction of 11 to 1 where the combined efficiency was 84 per cent., and he thought it would be rather a difficult matter to beat that. He considered the majority of engineers did not realise the care that was necessary to design worm gearing, and there was no reliable text-book in existence that properly treated the problem. If sufficient thought and care were bestowed upon the design and workmanship, nobody would repent employing it.

Mr. P. C. POPE said that when Mr. Clirehugh commenced his paper, he spoke about bleach works and dye works as being the best examlpes for motive power. He thought if they took a shipbuilding yard it would be a better example. They would get greater distances, and he thought the tools used were heavier than those used in a bleach works, and machines in the yard were also a great deal more scattered. There was an instance of this at Grays, West Hartlepool, where he heard they had adopted electric driving and had reduced the number of their boilers, and were now using only half the coal they used previously. Colliery work was, he thought, a still better example for the application of power; coal cutting, pumping, and hauling more especially. An even more advantageous use of electric driving is to be found in the application to machinery used intermittently, such as cranes and blowers for cupolas (which probably are not blowing more than about two hours a day), saw-benches, and wood-planing machines. The amount of labour required to look after a motive power plant was important. He knew of a case consisting of between 30 and 40 motors of sizes from ½ unit to 35 units. The total output of all the motors was about 250 units. There were 50 arc lamps and about 1,000 incandescents, and the plant was worked perfectly satisfactorily with two men, one of whom received 30s. per week and the other 22s. They did not know anything about the theory of motors, but simply looked after the brushes, oiling, &c. If a bad breakdown occurred, which was very seldom, they engaged an expert. The motors were running day and night, and they had no trouble whatever with them. They ran sparklessly at all loads—no load to full load.

Mr. C. H. WORDINGHAM said: For the same reason as Mr. Cowan, he did not wish to keep them very long, as there were many visitors there whom they would like to hear speak. There were one or two points, however, he would like to mention, and the first was in connection with the third paragraph of the paper, where Mr. Clirehugh said that power should not be distributed by means of a number of small motors, but rather that one larger motor should be put down. Owing to the courtesy of one of his consumers, he was able to give a very striking instance of the correctness of that. This consumer now took current for a 23 H.P. motor, and they used on the average 20 units per day. While they were waiting for this motor to be made, they used three small motors, with the result that they consumed 40 units per day for the same amount of work, so that the want of efficiency in that case was very strikingly shown. He could sympathise with Mr. Clirehugh as to the people who told him, when asking for the power of a machine, "that they used a pair of sixes." He had the same difficulty when finding out what power was required to drive mechanical stokers. He noticed in an American paper that the power taken by various machines, such as lathes and other tools, was largely over-estimated, that the motors put in often proved two or three times the size that they need have been. In connection with the worm gear, he could, in a somewhat different manner, very fully bear out what Mr. Atkinson had said as to there being a limit to the size of machine for which ball bearings were desirable. He had had them running for a considerable time on a machine of moderate size, but on putting them in a machine 50 per cent. larger, all the balls smashed up. The difficulty seemed to be in hardening them to the proper amount. He thought that quite bore out what Mr. Atkinson had said as to their failure for heavy weights. With respect to enclosed motors advocated by Mr. Clirehugh, he himself not long ago was extremely taken with the enclosed motor, but he had recently modified his opinion on account of the heating being so very great. He had a case on the Manchester circuit where two 16-ampere motors of the enclosed type are used, and he thought, but was not certain, that they had carbon brushes. The consumer complained that he found these motors working much too slowly on Monday mornings. It struck him that this was very remarkable, and it occurred to him as just possible that the explanation might be that these motors got very hot during the week, and had not time to cool down at night, but had plenty of time during the week end, and consequently the resistance of the field windings on Monday mornings was substantially lower. On testing them two weeks running, he found an enormous difference in the resistance of the field, and that actually did account for the motors running slow on Monday mornings. Coming to the question of cost, Mr. Clirehugh, perhaps naturally, only dealt with the cost where the power had to be generated by the consumer, but owing to the large extension of electric supply stations, there were many cases in which power could be taken from public supply mains. There certainly seemed every prospect of its extending to an enormous extent in Manchester. At present they had not a vast amount of power, but it was just beginning to take root and to find favour. At the present time he thought they had about 133 motors, aggregating about 235 H.P., while they had 18 more motors aggregating 150 H.P. applied for. The majority of those motors were supplied at 1½d. per unit, at which price electric power compared very favourably with either gas or steam. By the courtesy of the same consumer whom he had before referred to, he found that the 23½ H.P. motor put in was very much more economical than a gas engine, and was actually costing less than about the same amount of power developed for similar purposes at a mill they had where steam power was used. The results were most encouraging. The consumer quoted as an advantage of electric driving over gas engine driving, and also over steam, the great saving in floor space. For a gas engine they would have required six times the space, and the steam engine plant was taking 20 times the space, and in a city where land was expensive that meant an enormous saving in rent. They reckoned that they were saving £50 or £60 a year in floor space alone. The figures were obtained from an actual user, and the consumers were people who had gone into the matter thoroughly, and had only their own interests to serve. They found that they gained a substantial reduction.

Mr. CLIREHUGH, in reply, said he did not think that anything had cropped up in the discussion which necessitated a long reply, especially as it was getting very late. With regard to the efficiencies of generators and motors which he gave, he was still of opinion that it was not unreasonable to expect an efficiency between the B.H. of the engine and the B.H. of the motor of 80 per cent. There had been a good deal of interesting discussion on worm gearing, a subject on which many speakers appeared to hold opinions diametrically opposed to one another. If worm gearing were as inefficient as certain gentlemen suggested, how was it that if you enclosed in it an oil bath, and ran for 12 hours, the oil was perfectly cool. One speaker said that they would lose 30 per cent. Not assuming you had a motor developing 15 H.P., his contention was that you lost about 5 H.P. in the gearing; this loss, if it existed, would very soon, it seemed to him (Mr. Clirehugh), bring the oil bath to boiling point. He was somewhat disappointed that no speakers had suggested other forms of gearing, or discussed their efficiency. Mr. Atkinson's information on the subject on carbon brushes was most interesting, and explained the causes of the curious phenomena which were known to exist in connection with their use. With regard to Mr. Wordingham's remarks on the subject of the difficulty he had with the heating of enclosed motors, as he (Mr. Clirehugh) had pointed out in his paper, that if you enclosed a motor you can only run it at 75 per cent. of its rated output if you wish to keep the same temperature rise. Of

course, therefore, if you take an unenclosed motor which is doing certain work with a certain temperature, you cannot expect to do the same work with only the same rise when you enclose it.

COST OF ELECTROMOTIVE POWER IN NEW YORK AND MASSACHUSETTS.*

The figures in the following table are given from the last annual reports of the Boards of Railroad Commissioners in New York and Massachusetts for all or nearly all the street railway properties in those two States which operate power stations. The returns are arranged in the order of car mileage run for the year, as the magnitude of operation has theoretically an important influence on the cost of electromotive power.

Name of company.*	Cars owned.	Car mileage for year.	Cost of electric motive power.	
			Per car mile.	Per passenger.
Schenectady	14	70,000	·1138	·0121
Dunkirk and Fredonia	9	72,142	·0666	·0215
Gardner	6	79,058	·0523	·0112
Hoosick	8	92,231	0198	·0050
Hornellsville and Canisteo	6	94,680	·0185	·0055
Olean	11	117,530	0265	0076
Leominster and Clinton	14	122,306	·0354	·0092
Pittsfield	15	130,106	0378	·0066
Reading and Lowell	7	142,797	·0357	·0147
Greenfield and Turners Falls	13	160,078	0219	·0050
Athol and Orange	10	163,797	·0333	·0067
Hornellsville	9	177,025	·0171	·0114
Plymouth and Kingston	12	177,876	·0299	·0081
Kingston City	11	187,650	·0409	0074
Natick and Cochituate	15	189,767	·0322	·0081
Utica and Mohawk	8	204,306	·0255	·0083
Citizens (Fishkill)	25	213,190	·0242	·0066
Marlborough	14	220,151	·0198	·0060
South Middlesex	16	249,277	·0290	·0071
Gloucester	24	257,613	·0459	·0092
Hoosac Valley (North Adams)	29	279,480	·0292	·0061
Gloucester, Essex and Beverly	23	304,085	·0309	·0084
Ithaca	22	309,701	·0182	·0036
Watertown and Brownville	24	328,500	·0050	·0029
Braintree and Weymouth	20	329,374	·0374	·0135
Rockland and Abington	26	335,441	0413	·0097
Wakefield and Stoneham	20	335,780	·0143	·0037
Taunton	52	340,523	·0270	·0058
Newton	32	341,244	·0224	·0044
Auburn City	28	381,935	·0104	·0041
Norfolk Suburban	28	382,962	·0416	·0077
Quincy and Boston	42	397,014	·0170	0032
Buffalo, Bellevue and Lancaster	23	397,625	·0202	·0017
Haverhill and Amesbury	56	401,160	·0413	·0114
Newburgh	33	405,971	0231	·0057
Middletown-Goshen	21	414,210	·0142	0048
Geneva, Waterloo, Seneca Falls and Cayuga Lake	30	417,000		·0069
West Side (Elmira)	14	426,928	·0160	·0053
Niagara Falls & Suspension Bridge	29	444,652	·0177	·0054
Yonkers	29	445,190	·0374	0093
Northampton	30	496,648	·0163	0044
Elmira and Horseheads	48	595,590	·0169	0052
Poughkeepsie City and Wappingers Falls	20	550,108	·0129	·0038
Worcester and Suburban	48	619,408	·0315	·0063
Jamestown	50	627,784	·0231	·0059
Fitchburg and Leominster	37	631,137	·0210	·0062
Interstate Consolidated	55	652,577	·0281	·0078
Union (New Bedford)	88	747,915	·0207	·0030
Holyoke	69	803,712	·0179	·0042
Utica Belt	70	827,095	·0153	·0036
Binghamton	73	839,500	·0094	·0023
Globe (Fall River)	100	1,243,051	·0197	·0039
Syracuse Consolidated	113	1,266,923	·0204	·0091
Brockton	112	1,291,633	·0240	·0050
Lowell, Lawrence and Haverhill	143	1,443,730	·0243	·0043
Syracuse Street	106	1,687,463	·0140	·0040
Lowell and Suburban	144	1,802,093	·0146	·0034
Steinway	226	1,885,638	0147	·0042
Worcester Consolidated	139	1,929,992	·0426	·0084
Coney Island and Brooklyn	164	2,062,044	·0182	·0057
Troy	206	2,223,585	·0113	·0025
Albany	113	2,229,977	·0151	·0035
Brooklyn City and Newtown	272	2,332,536	·0188	·0033
Springfield	175	2,358,622	·0188	·0044
Union (N.Y.)	135	2,486,963	·0197	·0050
Brooklyn, Queens County and Suburban	309	3,389,491	·0220	·0048
Rochester	227	5,010,862	·0144	·0042
Lynn and Boston	519	5,379,216	·0188	·0038
Buffalo	255	6,262,500	·0178	·0012
Brooklyn Heights	1,811	21,500,745	·0086	·0017
West End	2,422	25,841,907	·0277	·0043

* Abbreviated.

* *Street Railway Journal.*

Of the nineteen companies operating less than 250,000 car miles per annum four only are obtaining motive power at a cost of less than 2 cents per car mile; six at between 2 cents and 3 cents per car mile; five at between 3 cents and 4 cents per car mile; one at between 4 cents and 5 cents per car mile; and three at more than 5 cents per car mile.

Of the 21 companies operating between 250,000 and 500,000 car miles per annum, nine are obtaining motive power at a cost of less than 2 cents per car mile; five at between 2 cents and 3 cents per car mile; three at between 3 cents and 4 cents per car mile, and four at between 4 cents and 5 cents per car mile.

Of the 10 companies operating between 500,000 and 1,000,000 car miles per annum, five are obtaining motive power at a cost of less than 2 cents per car mile; four at between 2 cents and 3 cents per car mile, and one at between 3 cents and 4 cents per car mile.

Of the 15 companies operating between 1,000,000 and 5,000,000 car miles per annum, 10 are obtaining motive power at a cost of less than 2 cents per car mile; four at between 2 cents and 3 cents per car mile, and one at between 4 cents and 5 cents per car mile.

Of the five companies operating over 5,000,000 car miles per annum, one is obtaining motive power at a cost of less than 1 cent per car mile; three at between 1 cent and 2 cents per car mile, and one at between 2 cents and 3 cents per car mile.

The Brooklyn Heights Railroad Company has the cheapest power of any steam plant in the list, $·0086 per car mile; the Binghamton Railroad Company follows with $·0094, and among the others whose costs of motive power are especially low may be mentioned the Wakefield and Stoneham Street Railway Company, $·0143; the Auburn City Railway Company, $·0104; the Middletown and Goshen Traction Company, $·0142; the Poughkeepsie City and Wappingers Falls Electric Railway Company, $·0129; the Lynn Street Railway Company, $·0140; the Lowell and Suburban Street Railway Company, $·0146; the Steinway Railway Company, $·0147; the Troy City Railway Company, $·0113, and the Rochester Railway Company, $·0144.

It should be noted that the reports of cost of electromotive power for all the Massachusetts roads include repairs and depreciation of station plant, which is not the case with the New York roads.

THE ELECTRIC LIGHTING OF THE BLACKPOOL WINTER GARDENS.

The question of installing generating machinery for electric light at the Winter Gardens was first mooted in 1895, and the decision eventually arrived at by the directors was, that the economies and advantages to be derived from the possession of their own generating machinery were such as to fully justify the capital expenditure requisite for the putting down of a first class plant.

The above decision, however, was only arrived at by the directors, under the able chairmanship of Mr. James Pearson, after most careful and complete investigations, and after having obtained the best professional advice.

Having thus decided to erect their own electric lighting plant the directors lost no time, and specifications having been prepared, the contracts for the work were placed early in 1896. Messrs. Tinkers, Limited, of Hyde, secured the contract for the boilers, pumps, steam and exhaust connections, &c., and the contract for the supply of the engines, dynamos, switchboards, &c., was placed with Messrs. Veritys, Limited. The directors also decided to retain Mr. E. M. Lacey, of Westminster, consulting electrical engineer, to advise on all matters in connection with the machinery and wiring.

This undertaking, which may fairly be described as the largest private electric lighting plant in the country. On the completion of the works there will be installed machinery of upwards of 1,100 H.P., capable of supplying current to 20,000 lamps at one time. It may be explained that many central electricity supply works for large towns do not approach this power.

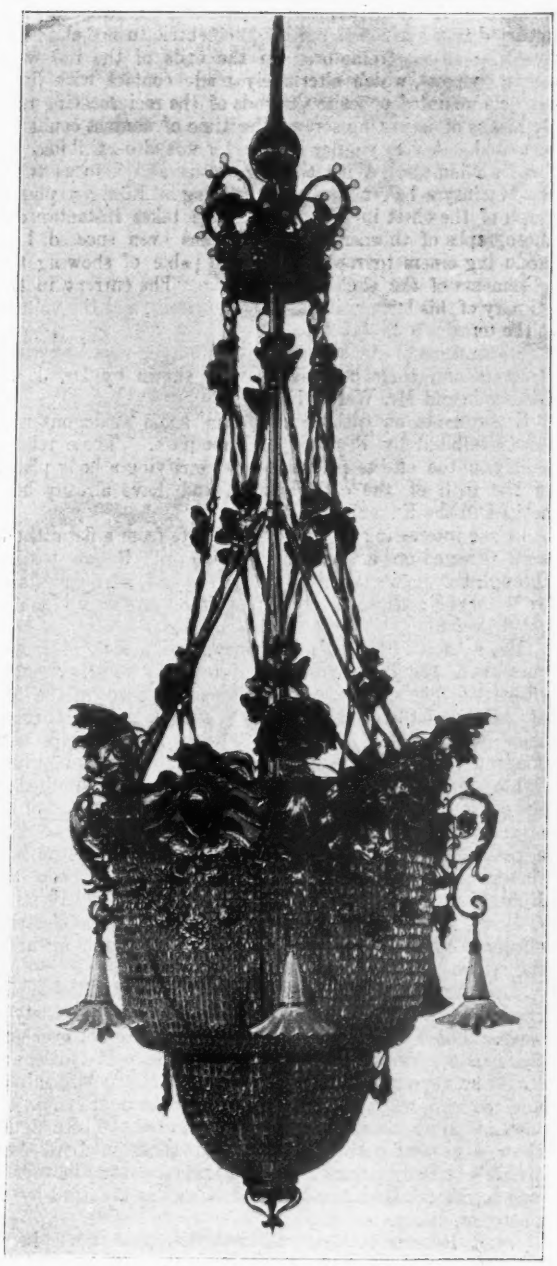
The boiler and engine houses are situated on the right-hand side of the new ball room, at the back of the Indian lounge, and will be open for the inspection of visitors at stated times. Four boilers have been fixed; three of these by Messrs. Tinkers are marine type, and are each capable of evaporating 5,000 lbs. of water per hour. The fourth boiler, by Messrs. Babcock & Wilcox, Limited, is of their well-known water tube pattern, and is capable of evaporating 8,000 lbs. of water per hour. This boiler is fitted with steam jet blowers for force draught, so as to ensure quick steam raising in cases of necessity.

The water supply is at present obtained from the Blackpool Corporation, and a storage tank has been provided holding about 7,500 gallons. From this tank the water is drawn by two Watson's vertical marine pattern pumps, each capable of delivering 2,500 gallons per hour and fed into the boilers through an improved exhaust steam feed water heater. Through this heater the exhaust steam from the engines is passed for the purpose of heating the feed water supply to the boilers. The system of steam piping is arranged in a ring form, valves being provided to allow of any portion being cut out without interference with the supply to the engines. The main and branch pipes are of mild steel with cast-steel flanges, the tie pieces being also of cast-steel. The bends and branches to the engines are of copper, and on the branch to each engine a McDougal steam dryer has been provided. Suitable means have been provided for draining the sections of the steam pipes. The main exhaust pipe is of cast-

iron, 15 inches diameter, and is carried up the chimney, branches being provided for the purposes of forming a way either through or by the heater.

When completed, the engine room will contain three Belliss quick revolution engines of 300 I.H.P. each, and one of 110 I.H.P. The dynamos are mounted on the engine bed-plates and driven direct.

At present two of these engines are erected, and the others in course of manufacture. They are three-cylinder compound type coupled to three cranks at 120°, and are each capable of developing 300 I.H.P. at 330 revolutions per minute, with a steam pressure of 140 lbs. per square inch non-condensing. The engines are of the enclosed type, with forced lubrication to all moving parts. The



governors are of the throttle valve type, and are extremely sensitive to small variations of speed. When tested the speed variations between full load and no load did not exceed 2 per cent., the test being taken by switching the whole of the load off the dynamo at one time.

The dynamos are of the four-pole type manufactured by Messrs. J. H. Holmes & Co., of Newcastle. The output of each machine is 1,750 amperes at 110 volts. When tested at the makers' works, each of the combined sets, engine and dynamo, was found to have an efficiency at full load of over 84 per cent.

The consumption of steam by the engines when working non-condensing with 120 lbs. of steam was 21 lbs. of water per I.H.P.

The switchboard was constructed and supplied by the contractors for the whole of the electrical plant, and consists of panels of enamelled slate supported on an iron framework.

The current from the dynamos is carried to omnibus bars on the board, and thence distributed to the various portions of the buildings. All the necessary regulating gear and measuring instruments for the whole installation are provided on this board. Each machine is provided with an automatic cut-out switch and shunt breaking switch. No trouble or expense has been spared to facilitate the easy working of the station.

From the engine room 12 distributing mains are carried to the various portions of the Winter Gardens, where they serve sub-switchboards off which circuits are taken to the lights. These main cables have been supplied by Messrs. Veritys, Limited, who have also executed the whole of the wiring for the new premises.

Each distributing board consists of separate enamelled slate slabs, mounted with bus bars, double pole fuses, and single pole switches enclosed in neat polished wood cases with glass doors. The largest of these controls 75 25-ampere circuits.

In order to give a general idea as to the magnitude of the installation, it would be well to state approximately the number of lights in the equivalent of 8 candle-power installed throughout the buildings and grounds:—

Empress ball room, stage and entrances, 1,980; Indian lounge, 1,000; Floral Hall, 1,000; Pavilion Promenade, 1,700; Opera House, 1,050; Pavilion Theatre, 3,500; Billiard bars, cloak rooms, &c., 500; Fernery, 400; Entrances, 700; new saloons, restaurant and offices, 1,200; gigantic wheel, 1,000; illuminated gardens, 3,000; stores, cellars, underground kitchens, &c., 350.

The lighting of the Empress Ball room is of the most brilliant description; in the centre are suspended three of the largest electroliers ever manufactured; each weigh 2 tons, the overall length is 28 feet, the overall width 11 feet 6 inches. The large cut glass bag can completely enclose 10 full sized men. The lighting of these fittings is by means of carefully blending arc and incandescent lamps of various candle-powers, the latter arranged in the ornamental brass work on the exterior of the fitting; the combination has the most brilliant effect, and reflects great credit on Messrs. Veritys, who have been bold enough to recommend its adoption. The general appearance of the fitting, as seen from the illustration given with this description, is extremely handsome, and Messrs. Veritys inform us that the bulk of the parts consist of hand beaten brass, the shells and shields being the largest that have ever been so made. The fittings are suspended from specially designed winches fitted with automatic brake, and so geared that the fittings can be raised or lowered by two men.

The general lighting of the ball room is carried out by means of 35 very handsome copper and brass electroliers suspended round the arches of first gallery, each containing four 16-candle-power incandescent lamps enclosed in handsome cut glass vases. The lower galleries and staircase are lighted by means of 7-light cluster fittings of hand beaten brass, and are also of handsome design.

The lounge adjoining the ball room has been treated in a plainer but most effective manner as regards the illumination of the fine decorations, there being no less than 744 incandescent lamps fixed to the ornamental plaster work on the arches which form the border round the room between the vaulted roof and the handsomely hand painted cove on the ceiling. From each of the domes are suspended very fine electroliers of Moorish design, the metal work being of brass heavily finished in electro-gilt, relieved with silver; one of these fittings contains 25 lamps and the others 10 each.

The general lighting of the grounds and front entrances to the buildings is carried out by means of over 200 arc lamps.

The vaulted roof of the floral hall has been studded with hundreds of incandescent lamps of various colours, and the effect of these, when viewed from among the fine palms which abound in this portion of the premises is extremely artistic.

The lighting of the new Pavilion stage will be carried out on the latest and most approved lines, and will be on a more extensive scale than any other theatre in this country, as the Winter Gardens Company are noted for the magnificent electrical effects which they produce every year in their ballets.

The whole of this important installation has been carried out by Messrs. Veritys, Limited, from their Manchester offices, under the personal and able supervision of Mr. Charles S. Northcote, the company's manager for Manchester and the North of England, and the Winter Gardens Company have appointed Mr. A. R. Sillar, their resident electrical engineer.

Valuable services Messrs. Veritys inform us have been rendered by the manager, Mr. Charles R. Brighten, and by the chairman, Mr. James Pearson, who have spared neither time nor trouble to make the undertaking a complete success. It has been a great advantage to the company and a valuable saving of time to have had the benefit of such experience and advice as they were able to contribute, and the company have reason to be grateful to the directors and their contractors for the business-like manner in which they have devoted themselves to this important work.

THE COST OF LAYING ELECTRIC LIGHT CONDUITS IN SHOREDITCH.

It will, perhaps, be remembered that in the early stages of the electric lighting scheme for Shoreditch, the vestry decided to entrust to the surveyor's department the work of laying the conduits for the electric light mains. The first section of the work has been completed, but without waiting for the publication of the accounts, the Chairman of the Electric Lighting Committee stated at a meeting of the vestry on April 27th, that the carrying out of the work by the vestry's own staff had involved the parish in an extra cost of £5,000 above what the work would have cost by contract

This reflection upon the surveyor's department induced Mr. J. Rush Dixon, Assoc.M.Inst.C.E., surveyor to the vestry, to investigate the matter, with the result that the Works' Committee at the meeting last week presented a report submitted by the surveyor as to the actual cost of laying the conduits. The report is essentially as follows:—

SURVEYOR'S REPORT.

The work was commenced in April, 1896, and was not completed until April 16th last, the account having just been properly made out, although the statement was made to you on April 27th.

The total cost of the work done, including the trenches for telephone company's mains, amounts to			£7,424 7 7
The amount to be refunded by the telephone company amounts to	£1,495	3 6	
Which, with an allowance of ...	109	15 10	
Made for plant, tools, &c., returned to stock, makes a total deduction of			1,604 19 4
Leaving the net cost chargeable to the Electric Lighting Committee of			£5,819 8 3

The total length of trenches opened upon footways, carriageways, crossings for electric lighting conduits, lamp connections, boxes, &c., has been 18,375 yards, or about 10½ miles, which length divided into the total cost works out at 6s. 4d. per yard run.

An additional length of 333 yards was excavated exclusively for the telephone company's mains.

In many streets the conduits are laid at a considerable depth below the surface, as much as 8 feet in places, on account of the numerous gas, water, and other mains being in the way, and when laid under the carriage-ways has necessitated a depth of from 6 inches to 12 inches of hard concrete to be broken through and afterwards re-instated, which was very heavy and laborious work indeed.

For the greater part of the work three gangs were working in different streets at the same time, at the special request of the Lighting Committee, who feared the laying of the conduits was not keeping pace with the fitting up of the generating plant, but this, although causing greater expense by giving less opportunity for the proper and required supervision of the very casual workmen, has proved quite unnecessary.

Vaults, pipe connections, and branch drains have been interfered with, and required much attention and careful repair, the whole cost of which is included in the before-mentioned total, except an amount for compensation claims, accidents, and other extraneous matters, which are estimated to amount to £300. Of the £5,819 8s. 3d., £4,980 2s. 9d. has already been credited by the Electric Lighting Committee up to December 4th last, and an account for the balance of £839 5s. 6d. is now before them.

The Telephone Company have paid £741 3s. 6d. towards their total account of £1,495 3s. 6d., and the balance will be forthcoming in due course.

The contract recently entered into by the Vestry is for 8s. 6d. per yard run, but this includes for the supplying and laying of two way 4 inch conduits.

In conclusion, Mr. Rush Dixon states that these figures will be sufficient to at once remove the unfair reflection which has been cast on the work of this department, which, throughout this unusual work, has used every endeavour to carry out the same as efficiently and economically as possible.

When this report came up for discussion last week it was decided to appoint a committee of seven members to further investigate the matter.

THE ROYAL SOCIETY CONVERSAZIONE.

AT the second annual conversazione of the Royal Society on June 16th, the electrical exhibits were of considerably greater novelty and interest than at the first. These exhibits showed the great importance that is now being attached by scientific men to the investigation of electric oscillations. Mr. Preece gave a demonstration of the two methods of signalling through space without wires, invented by Marconi and by himself. The first he calls the electrostatic method, and the second the electro-magnetic. But it is difficult to see the reason for this distinction; the rapid Hertzian waves which are produced by the Marconi apparatus are as much electro-magnetic waves as the slower oscillations produced by the Preece apparatus. Mr. Preece's experiments were remarkably successful, but there could be no doubt as to the Marconi system being much more efficient than the Preece system. The Marconi receiver appeared somewhat mysteriously to ring when the Marconi transmitter was not in action; but this may have been due to the presence of a rival radiator which was being exhibited by Dr. Muirhead in another part of the building.

The apparatus exhibited by Dr. Alex. Muirhead was labelled "signalling by Hertz waves as practised by Dr. Oliver Lodge in 1894, with a Branly tube of filings as receiver, and now adapted to a Kelvin recorder." The radiator or emitter of this apparatus was very simple, consisting of a pair of brass balls separated by an air spark gap of about 1 inch, and connected to discs of about 8-inch diameter, which replaced the rectangular wings in the Marconi transmitter. The balls were connected to the secondary of an induction coil, whose primary current was controlled by dots and dashes punched out in a ribbon fed by clockwork, as in the ordinary automatic telegraph transmitter. The message was accurately reproduced in the Morse alphabet by a modified Kelvin recorder some 40 to 50 yards away in another room.

Dr. John Macintyre exhibited a very powerful apparatus for the production of Röntgen rays. The induction coil used was capable of giving an 18-inch spark in air. The interrupter was of a special design, and was said to be very efficient. A longitudinal reciprocating movement was imparted to a horizontal rod by an eccentric turned at a high speed by an electromotor. On the ends of the rod were spring contacts, which alternately made contact with fixed contacts mounted opposite the ends of the reciprocating rod. By means of adjusting screws the time of contact could be regulated. A very similar interrupter was also exhibited by Sir D. Salomons. With this apparatus and a focus tube, Dr. Macintyre has succeeded in getting a Röntgen photograph of the chest in 10 seconds. He takes instantaneous photographs of thinner bodies; and has even succeeded in producing cinematographic ribbons capable of showing the movements of the skeleton of a frog. The current in the primary of his large coil is about 8 amperes, and the voltage at the terminals 4.

Illustrations of the absorption of Röntgen rays by certain elements and their compounds were shown by Dr. J. H. Gladstone and Mr. Walter Hibbert.

Experiments on cathode rays and some analogous rays were exhibited by Prof. S. P. Thompson. These related chiefly to the effects produced by electrifying a body placed in the path of the cathode rays, and have already been noticed in the ELECTRICAL REVIEW.

In one interesting experiment the rays from a flat cathode were directed on a metal gauze screen. Before passing through the gauze, the rays were green and were deflectable by a magnet; after passing through, the rays were blue and not deflectable.

Mr. A. A. C. Swinton's experiments with high frequency currents of the Tesla type were, if not very novel, extremely effective. The spectators were allowed to perform the feat of lighting a 16-candle lamp by a current passing through their own bodies. A number of incandescent lamps were connected up between the sides of a U-shaped wire, and lighted up to full incandescence, though short circuited by the curve of the U, giving a very striking illustration of the objection which high frequency currents have to traversing a path having much self-induction. Mr. Swinton also showed his well-known experiments with cathode and Röntgen rays, and the experiments of Birkeland and Fleming.

Lord Kelvin had an exhibit illustrating the electrical effects of uranium, or electric conduction through air under the influence of uranium.

Lord Armstrong exhibited some of those inexplicable electric figures which he has recently produced in a variety of ways. These figures were produced by discharges over surfaces of a resinous or bituminous nature. The discharge leaves no appearance on the surface until dusted with sulphur and red lead, when the positive parts of the figure come into view in yellow tints, and the negative in red. These figures show a general correspondence with those in Lord Armstrong's recently published monograph on electric movement, but do not exhibit such perfect detail as is obtained by the photographic method.

Prof. Roberts Austen exhibited diamonds made in the electric furnace by Moissan's method, slightly modified. The size of the diamonds produced did not exceed ½ mm.

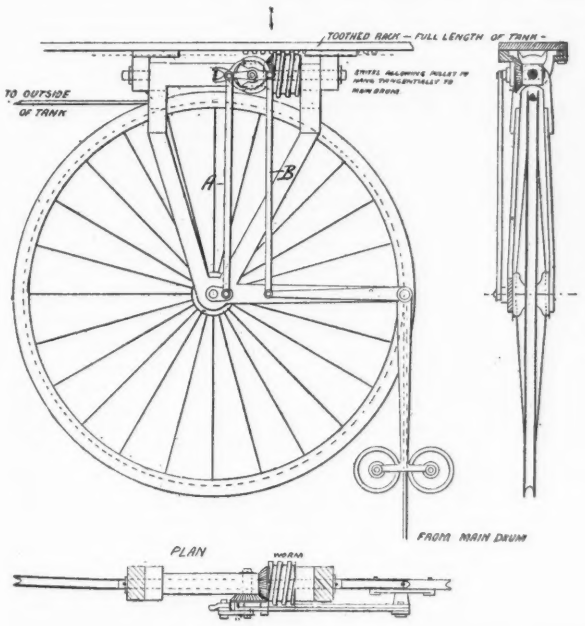
CORRESPONDENCE.

Rapid Cable Laying for War Purposes.

Amongst other points upon which you touch in your criticism is the automatic mechanism inside the main tank; with regard to this I send a sketch, and in connection with the explanation given in Appendix B in your issue of May 21st, and the illustration on page 689 of the issue dated May 14th, there is, I hope, no difficulty in understanding the action. The speed of filling the main drum would

be 20 knots per hour, as there is no reason why it should not be taken in at full speed, from a suitable drum on shore, provided a "cable accumulator" intervenes, to meet small discrepancies in driving rates, and a few other precautions are taken. However, this rate of replenishing is much exceeded in the small unit system, as the taking out of empty drums and replacing by full ones surely need not exceed half an hour per unit of 40 knots, or 320 knots in 4 hours, as against 64 hours by hand to coil the same amount in ordinary tanks. What this advantage might mean in war time it is difficult to estimate.

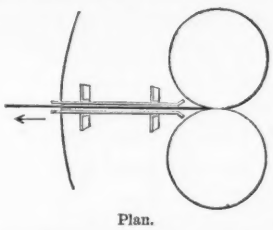
With regard to *slip* on the stern pulley by reason of too few turns, this is easily met, of course, by increase of depth to the rim, and such guards as may be found necessary could be affixed. As regards a guide for the driver of the accumulator engine, I have already explained that it requires no driver, with the large drum system, but with small units the driver's duty is to keep his accumulator approximately full, and therefore the state of the drums themselves show him what to do. If the "ejector" speed is increased he sees



his reserve being eaten up and he increases his speed; if the "ejector" slacks down he finds his spare marginal space on the drums filling up, and he consequently eases his engine. Plainly, this is a most simple duty, as no *sudden* changes are likely to occur in regard to the ejector; even if the ship lost her propeller when travelling at full speed, all cable gear could be comfortably slowed down immensely more rapidly than the rate the ship would lose her way. Certainly, speaking communication as you suggest, would be desirable between the two stations.

It is easy, however, and perhaps desirable, until the time approaches for changing the supply from drum to drum in the hold, to place the accumulator under automatic control, more especially as it is so simple to effect. For instance, the shaft carrying the tangent sheave has an extreme range of about 50 revolutions; therefore, suppose on reaching 45 revolutions it is caused to gradually reduce the steam supply to the engine driving the receiving drum, plainly, by suitable gear, it is quite feasible to make it *impossible* to over-fill the accumulator, for the driving power can be cut off, and if need be, brake applied automatically. On the other hand, if the ejector commences to eat up the cable reserve on the accumulator, the resulting backward rotation of the torsion shaft may open up the supply of steam to the receiving drum engine, until the fulness of the accumulator again causes the steam supply to be lessened. Thus we have *perfecc interdependence* between the ejector and the accumulator, or we have an analogous action to that of a cistern governed by a ball cock. It is unnecessary, I presume, to accompany this description by a sketch, as the arrangements needed would be obvious to any engineer.

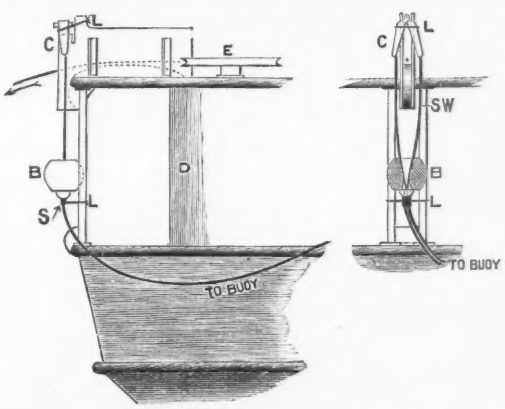
The only other matter referring to laying the cable, to which I have to reply, is the method of buoying at full speed. Referring to the illustration on page 725 (May 21st), let us suppose that the Port authorities have anchored a buoy by a mushroom, as shown, with a pair of heavy shore ends brought out and held in clips at the side of the buoy. Our



Plan.

cable ship passes as closely as convenient to the port buoy, and drops her own one to hold up the bight of the cable, whilst she proceeds on her voyage. Cutting the bight and joining up the shore ends (the buoys then being both removed), puts the Port in connection eventually with the two terminal stations.

In using the ship's buoy, it would be easy to detach it by methods in use for boat or anchor releasing, and as will be seen by the sketch herewith (illustrative of the system, but not accurate as to detail), the cutting of the "lashings" at the clamp and ball, when the buoy is detached, will release the whole appliance, which in a very short time settles itself, as shown in the illustration on page 725 (ante). If the lashings, which need not be strong, were not cut, but parted by the drag of the buoy astern, no harm would result. The clamp grips the cable tightly, and if it is desired to cut the cable almost directly after detaching the buoying appliance, the end cannot slip through. To rig the gear in place, the centre pin of the clamp is first knocked



Side view. End view.

B, Ball C, Clamp; D, Deck house; E, Ejector; L, Lashing; S, Stop; S W, Steel wire rope.

out, the two ends passed up separately at the sides of the channel, and the clamp repinned, placed astride of the channel, and lashed. Meantime the cable ejecting goes on uninterruptedly.

I may mention that various additional details, such as the use of sectional buoys, I have kept in abeyance, as it might be argued that the system throughout was too full of details to be feasible; some people in fact I have found, if given too much to digest at once, cannot differentiate between the main backbone of the invention, upon which success primarily depends, and the supplementary accessories which are called for under the special conditions of cable laying which war would entail. Sectional buoys I had perhaps better state form a convenient system of building up a large buoy by a number of small ones, which can be readily stowed out of sight, so as not to allow an enemy to get an idea of the operations in hand, also to allow the upper section to be perforated by a small quick-firing gun, without causing the equipment to sink quite to the bottom. Thus if a secret position has to be temporarily abandoned, the buoy may afterwards be readily recovered by "creeping" with a rope,

in default of *special* appliances, which would not be found on every warship.

In conclusion, I hope I have satisfactorily disposed of the objections raised, arising as they mainly have done, I think, for want of fuller description than could possibly be given in the limited space of a single paper; if you find I have done so I hope you will so express yourself, for I am persuaded that the use of light strategic cables for war purposes will have no inconsiderable effect upon the next naval war in which Britain is engaged, and, I may add, I am far from being alone in my opinion.

C. Scott Snell.

53, Victoria Street, S.W.

Sullivan's Method of Determining the Relative Positions, and the Top and Bottom Ends of Several Cables in a Tank.

In reply to your interesting comments upon my paper in the *Electrician* dealing with the above method, I should like to make a few further remarks, which I venture to think may be of interest to your readers.

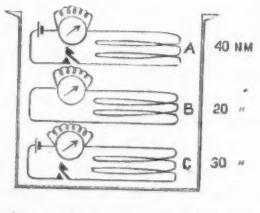
Quoting from your article you say:—"With regard to this part of Mr. Sullivan's highly ingenious test (referring to the determination of the relative positions of several lengths), it appears possible that the inductive effect alone might not be quite sufficient in the case of a short section of, say, only one flake, to indicate its position with certainty, unless its approximate length—as shown by its C R when tracing the ends—be also taken into account, as that would seem necessary, in order to form a rough idea as to how much inductive effect should be expected. This knowledge, in conjunction with Mr. Sullivan's test, would more clearly show whether its position must be above or below another section." Now, if there be any inductive effect at all in the supposed secondary, no matter how small it may be, provided it is sufficient to give an appreciable deflection on the galvanometer, the looping of a length of cable between it and the primary will reduce that effect; consequently, if any section of cable when treated as the secondary exhibits the same amount of inductive influence whether the other cables in the tank are looped or freed, we are certain that that section lies immediately underneath the primary.

It is obvious, therefore, that a previous knowledge of its C R and approximate length is not really necessary for the success of the test.

Having regard to the great strength of the induced currents as observed during Mr. Sullivan's experiments with cables of small type, it seems scarcely conceivable that the inductive effects would be insufficient for the purposes of the test, even were the cable only one flake or thereabouts in length.

My next point is still more important. To quote from your remarks again, you say: "We would suggest that when one of the sections is very short, it would be advisable, after finding its top and bottom end by Mr. Sullivan's test, to connect it in circuit with the longer section above, so that the combined influence of these two sections, acting as the primary circuit, may exert a stronger induction when testing for the next secondary section below."

Now, by adding to the length of the primary quite the opposite effect would be produced, for the reason that the increased resistance would lessen the current in milliamperes flowing through the primary, and consequently the induced effect in the secondary would be *decreased* and *not increased*. This was ascertained experimentally by Mr. Sullivan at the same time as the other tests given in my paper were taken, and I append the figures:—



Referring to fig. 1 and to my original paper, when A was made the primary, D with a shunt of 5 ohms was found to be 83 divisions (right), and the current induced in B or *d*, with the same shunt, was 30 divisions (left). When C was made the primary, D became with the same battery and shunt 115 divisions (right), and the current induced in B or *d*, was 40 divisions (left). It will thus be seen that notwithstanding its greater length the top cable, A, exerted less inductive influence upon B than did the bottom and shorter cable, C; viz, 30 divisions as against 40 divisions, or 33 per cent. less. It is true that the top cable, A, was brass taped, which it may be argued would serve to lessen the inductive effect between A and B owing to the supposed screening of the brass tape; but on the contrary, however, we find that notwithstanding its brass taping the top length of 40 nauts induced practically the same percentage of its current in milliamperes in the middle length as was induced in the latter by the bottom and non-brass taped cable. With regard to your point that a counter inductive influence would be exerted upon the secondary by a looped section lying above the primary, no doubt this is true; but its relative distance being so much greater, the effect would be proportionally smaller, and it could be rendered smaller still by freeing the ends as suggested in your article. With this modification I think the test would be thoroughly reliable under every conceivable condition. With respect to the question of faults existing in the primary or secondary, or in both of them, my original manuscript should have read "a fault or faults."

There is but one other part of your clear and concise article to which I may in conclusion refer. I allude to your comments upon Mr. Sullivan's second method of indentifying the ends when the cables are not all coiled in the same direction in which you state:—"We do not consider that this is the *whole* explanation, since the fact that the top end of Section B is free (as shown in fig. 3) would also partly account for that end, not developing such strong induced currents, as in the case of fig. 2; while at the same time the turns connected with the galvanometer in fig. 3 are more distant, and the currents induced in them consequently weaker."

This is without doubt a complicated problem, as under the given conditions it is difficult as regards the secondary cable to distinguish between the effects due to *induction* and those due to *conduction*, when measuring the throws at either end of the secondary cable. It is, however, quite evident that any current induced in that flake of cable which is nearest to the primary must immediately circulate through the secondary down to earth by way of the farthest flake, irrespective of such currents as are directly induced in the more distant flakes by the primary.

However, as you remark, the test is without doubt a good and useful one; and it is, of course, only necessary that the length of the secondary cable should be such as to give a measurable difference of potential between its two ends. It has been found that when dealing with a secondary cable of 60 nauts in length, this difference of potential amounted to nearly 100 per cent., which would seem to offer an ample margin for the reliable execution of the test. Further experiments in this interesting field by those having the necessary facilities at their disposal might with advantage be undertaken with a view to increasing our theoretical knowledge of the phenomena which have been so usefully and practically applied by Mr. Sullivan.

F. Alex. Taylor.

Uninsulated Pipe Wiring.

The letters and articles on this subject that have appeared lately in the columns of the REVIEW are undoubtedly of interest, but hardly of such value from a practical point of view as one might wish for, since for the most part they seem to be merely expressions of opinion on the part of those favouring either the plain or lined tube as the case may be, with a sprinkling of information thrown in as to what is being done in the matter in America; the latter point is of slight importance to us in England, as the conditions of building and our notions of wiring are very different from those obtaining in the States. What is required here before insulated tubing can become a standard article is for some one to tell us from actual experience whether properly made plain tubing carefully used is really so unsatisfactory as the advocates of the lined pipe would have us believe, and why it is so.

We are told of the awful fate in store for those who use unlined barrel, but I am unable to find in print a single reference to any place where it has been intelligently used and found wanting.

Given a tube with a smooth interior, as to which there need now be no difficulty whatever, the one great bogey in connection with plain tubing is the alleged condensation on the inside of the pipes; whether this condensation really does take place, and if so, under what circumstances and what harm it does when all the materials employed are of the best, are matters that can only be properly spoken to by those under whose notice it has come; and surely this is a case where an ounce of experience is worth all the theory in the world; if only some one who has used the plain tubing on a large scale and in an intelligent way, and has found difficulty from condensation, will tell us in your columns all about it, surely it will do more to set the question at rest than anything else.

During the past eight years some hundreds of thousands of feet of uninsulated pipe wiring has been done under the writer's notice, in every sort and kind of place, and up to now there has not been the slightest trouble from condensation, so that it is a little difficult to understand why it should be necessary to go to the expense of insulating your pipes, to say nothing of the inconvenience arising from the increase in external diameter rendered necessary by the insulation.

As the author of the paper on the subject in a recent issue of the Review pointed out, dampness should not frighten those who select their tube, use good wire, and vulcanise their joints; and on this head it may not, perhaps, be inopportune to point out that in the report of the operations of the Metropolitan Electric Company for 1896, the cost of maintaining all the rubber cables laid by the company in iron pipes under the London streets did not exceed £50 on a capital outlay of £200,000 during the year; those who are aware of the state these pipes and the cables in them get into after they have been laid down under the pavements some little time, will realise the very great practical importance of a definite statement of fact of this nature; it is of the greatest possible value to those who pin their faith to the use of good cables in uninsulated tubing.

In pipe wiring, as in everything else, there are various degrees of excellence, and those contractors—there are many—who put their wires into ordinary gas barrel in such a way that none of the work can be opened without pulling down the greater part of it, and who will wire a large building without a single joint or draw-box, and make difficulties about vulcanising their joints, must expect trouble; but when intelligently done by careful men, with good wire and clean pipes, unlined tubing appears to answer every purpose.

Experience can only settle the matter properly, and in this respect old users of unlined pipes are at an advantage, for they will have learnt by now where weak spots are likely to be found, and will have taken steps to overcome any difficulties that may have been met with; insulated pipe, as the child of the past year or two, has yet to go through the mill of prolonged use under various conditions in England, and it will be time enough then for those interested in the manufacture and sale of it to draw attention to its virtues.

Solid drawn steel pipe, such as the piece sent with this letter, can be obtained from Lloyd & Lloyd, the Mannesmann Company, and other makers of steel pipes; it is far smoother in the bore, and cheaper than the insulated barrel, while the external diameter for the same "carrying capacity" is considerably less.

G.

BUSINESS NOTICES, &c.

Belt Driving.—An interesting catalogue has been issued as "a guide to belt driving" by Messrs. John Tullis & Son, of Glasgow. A paper on the subject by Mr. John Tullis prefaces a number of sketches of various modes of belt driving. Leather link belting is described, and its advantages pointed out. Among the many illustrations we notice photographs of the Manchester Corporation electric light station, showing dynamos driven by Tullis's patent flexible centre link belts, dynamos at Earl's Court Exhibition driven by Tullis's patent orange tan leather belting, also dynamos at the City and South London Electric Railway station driven by link belting. A variety of belting accessories are detailed.

Electrical Wares Exported.

Week Ending June 22nd, 1896	£	s.
Alexandria. Teleg. mat.	240	0
Amsterdam	120	0
Antwerp. Electric fuses	165	0
Bombay	57	0
„ Teleg. mat. ...	17	0
Boulogne	70	0
Brussels	22	0
Buenos Ayres	194	0
Calcutta	93	0
Cape Town	128	0
Colombo	33	0
Durban	705	0
East London	65	0
Fayall	15	0
Flushing	10	0
Fremantle	41	0
Gibraltar	36	0
Gothenburg. Teleg. wire	17	0
King George's Sound ...	13	0
Oporto	31	0
Passages. Teleg. mat. ..	24	0
Port Elizabeth	425	0
Rangoon	14	0
Santos	31	0
St. Petersburg	38	0
Shanghai	120	0
Stockholm	620	0
„ Teleg. mat.	224	0
Sydney	498	0
Syra. Teleg. mat. ...	50	0
Wellington.	140	0
Yokohama	3,500	0
Total	£7,756	0

Week Ending June 22nd, 1897.	£	s.
Archangel	290	0
Bangkok	12	0
Calcutta...	187	0
Cape Town	820	0
Colombo	24	0
Delagoa Bay	18	0
Durban	37	0
Gothenburg	60	0
Ibrail	19	0
Lyttleton	23	0
Madras	9	0
Otago	18	0
Panama...	186	0
Port Elizabeth	306	0
St. Petersburg	100	0
Santos. Teleg. mat. ...	53	0
Stockholm	590	0
„ Teleg. mat.	414	0
Sydney	125	0
Wellington	100	0
Yokohama	28	0
Total	£3,419	0

Croydon.—Prof. Kennedy's report on the proposed electric lighting extensions here has been adopted by the Council.

Edison-Bell Phonograph Company, Limited, v. Taylor.—In this case which was to restrain infringement of the patents of the plaintiff company, Mr. Justice North on Saturday made the usual judgment order.

Fire.—Last Saturday afternoon a fire broke out in front of the premises of the Adelphi Stores, a public house adjoining the Hôtel Cecil, in the Strand. Extensive decorations covered the whole of the front of the premises, and some hundreds of electric lamps were placed round each of the windows, intermixed with the floral decorations. According to Monday's *Times* these were being tested, and when the current was switched on a loud crackling was heard, which was immediately followed by a blaze of light. The decorations at once caught fire, and in a minute or so the whole front of the building appeared to be in flames. These, however, were soon extinguished by the electricians and Mr. Wickham, the manager, under whose instructions the current was switched off, and the wires disconnected from the building. None of the passers-by were injured by the falling wire and lamps, but the occurrence attracted a crowd of some hundreds of persons. The fire is said to have originated through "short-circuiting."

For Sale by Tender.—The Huddersfield Corporation have for disposal a 100 H.P. compound vertical Brush engine and a 50-unit Mordey alternator. Electrical engineer, Mr. A. B. Mountain. See our "Official Notices" for further details.

Jubilee Illuminations.—The Bedminster Tobacco Factory at Bristol, of Messrs. W. D. and H. O. Wills, Limited, was elaborately illuminated for the Diamond Jubilee by Messrs. F. W. Ball & Co., 1,000 lamps being used. Celluloid balloons and small coloured lamps were used in profusion. A central transparency of the Queen was surrounded by 450 lamps. Messrs. Ball have carried out a good deal of illumination work at Bristol during the past week or so, including street illuminations in Wine Street, 250 lamps; street illuminations in High Street, 180 lamps; the Bristol Council House, 250 lamps; the Constitutional Club, 150 lamps; Messrs. Dunlop, Mackie & Co., 200 lamps; Messrs. Randall & Wall's, 100 lamps; the *Times and Mirror* offices, 130 lamps; and the *Western Daily Press* offices, 900 lamps.

Medical Batteries.—The application of electricity in medical work has not been so extensive in this country as is to be desired, and the disrepute into which this branch of electrical and medical science was brought a few years ago is probably, in a measure, accountable for this state of affairs. That electricity can be applied to certain diseases and weaknesses of the human system with remarkable success has been over and over again evidenced by the results recorded by specialists in electro-medical practice especially on the continent and in the States. Mr. A. L. Sardy, of Shoe Lane, E.C., who represents, in this country, the Chloride of Silver Dry Cell Battery Company, of Baltimore, is introducing upon the English market a variety of dry cell medical batteries containing Willms interchangeable cells. These batteries, we understand, are largely used in the States and other parts of the world by electro-therapeutists. We illustrate in fig. 1 a Faradic battery (No. 14) which contains four

Willms interchangeable dry cells, the cells appearing as in fig. 2. It is stated that this battery differs essentially from any ever before constructed. The cells are secreted from view, being encased in metallic interchangeable cell cases, which are in turn attached to and suspended from a hard rubber plate at the back of the battery case, and are arranged in such a manner as to permit anyone to readily disconnect and remove them, so that fresh cells can be put in their places when they become exhausted. Fig. 2 gives a view of the cell cases attached to the cell-supporting plate as they appear when lifted out of and away from the case. The coils are three in number—*i.e.*, a primary and two secondaries, each being wound with a different size of wire, the primary with No. 26, the first secondary with No. 22, and the second secondary with No. 32 wire. Each coil can be used independently of the others, and suitable connections have also been made by which the primary can be combined with either of the secondary coils, thus placing five distinct currents at the command of the operator. The strength of current in this battery is increased and diminished by means of a Willms current controller, which is placed permanently in the circuit, this controller being of the latest improved form, and constructed so as to insure the most perfect control over the variations of current strength. With the aid of this instrument the current in the beginning can be made so mild as to be scarcely perceptible, while it can be increased so gradually as to permit one to apply it with perfect comfort and safety to the most nervous person or delicate babe. The maximum power that may be obtained from this battery is sufficient for any case for which Faradism would be used in ordinary practice. In addition to other features, this apparatus is provided with a cell-selecting switch, by means of which either two, three or four cells can be used at a time—permitting one to practise economy in the use of the apparatus—a current reverser, and a contact breaker for diagnostic purposes. Such care has been observed in the arrangement of all switches and connections with the view of making them as simple and easy to understand as possible, that not only is it suitable for the physician, but is recommended to those of his patients desiring a most complete Faradic apparatus. We, however, do not advise the application of electricity to any and all diseases indiscriminately and without the aid of a medical man. It may in some cases do more harm than good. A great point claimed for the cells is that they do not waste whilst not in use. In fig. 3 we show one of the cells. It is claimed that all chemical action ceases in these interchangeable dry cells the moment connection between the terminals is broken. They can therefore remain unused for any number of years without deteriorating in the slightest. Fig. 4 shows a 50 cell chloride of silver dry cell test battery. Each cell gives practically 1 volt E.M.F. This battery has a pole changing switch in the cover of the box, and selecting cords and tips, by which the convenience and adaptability of the battery is ensured. The outside dimensions of a battery of fifty cells are 6 × 7 × 10 inches; the weight about 10 lbs. This battery has seen ten years of service under every variety of conditions. It is claimed that they are constant, will not dry out, have a long life, and there is not the slightest local action developed. The Edison General Electric Company, of New York, have used a number of these batteries for testing insulation resistances in underground work for a number of years. For six months they have used 500 of the batteries for testing Siemens cables in the factory, where their constancy, reliability, and cleanliness has been greatly appreciated.

(*Continued on page* 885.)

FIG. 1.

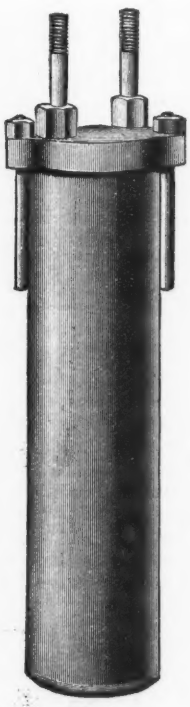


FIG. 3.

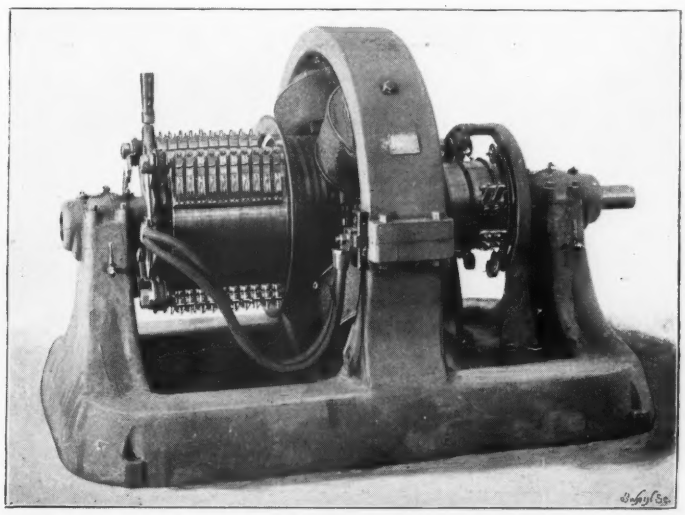
FIG. 2.

FIG. 4.

THE CHICAGO EDISON COMPANY.

By HAROLD LOMAS and HERBERT C. GUNTON.

Chicago, situated at the south west corner of Lake Michigan, contains at the moment of writing 2,000,000 inhabitants and covers an area of 144 square miles. It has grown at a phenomenal rate, and the progress of electric lighting has been well taken care of by the Chicago Edison Company. The Edison Company was incorporated in 1887, and started with a small station on the three-wire system at Adams Street, in the very heart of the business centre. There was then another company in the field, namely, the Chicago Arc Lighting and Power Company, who ran series arc circuits at 2,580 volts, and supplied direct current for power purposes at 580 volts, and alternating current for incandescent lighting. The steady growth of the Edison Company caused the erection of the Wabash Avenue station on the south side in 1889.



100 kw. 3-Phase Rotary Converter, 4 Poles 750 Revs. per Minute.

In 1892 came the consolidation with the Arc Lighting and Power Company at Market Street, and as low tension plant has also been laid down there it contains no fewer than four different systems. Besides this the north side station was started in 1893 to meet the demand in that direction.

It is not our intention to describe these stations in detail, as the habit of the Edison Company of absorbing into itself other companies has the result of making them possessors of plant of widely differing kinds, the adapting and weeding out of which requires considerable time and skill.

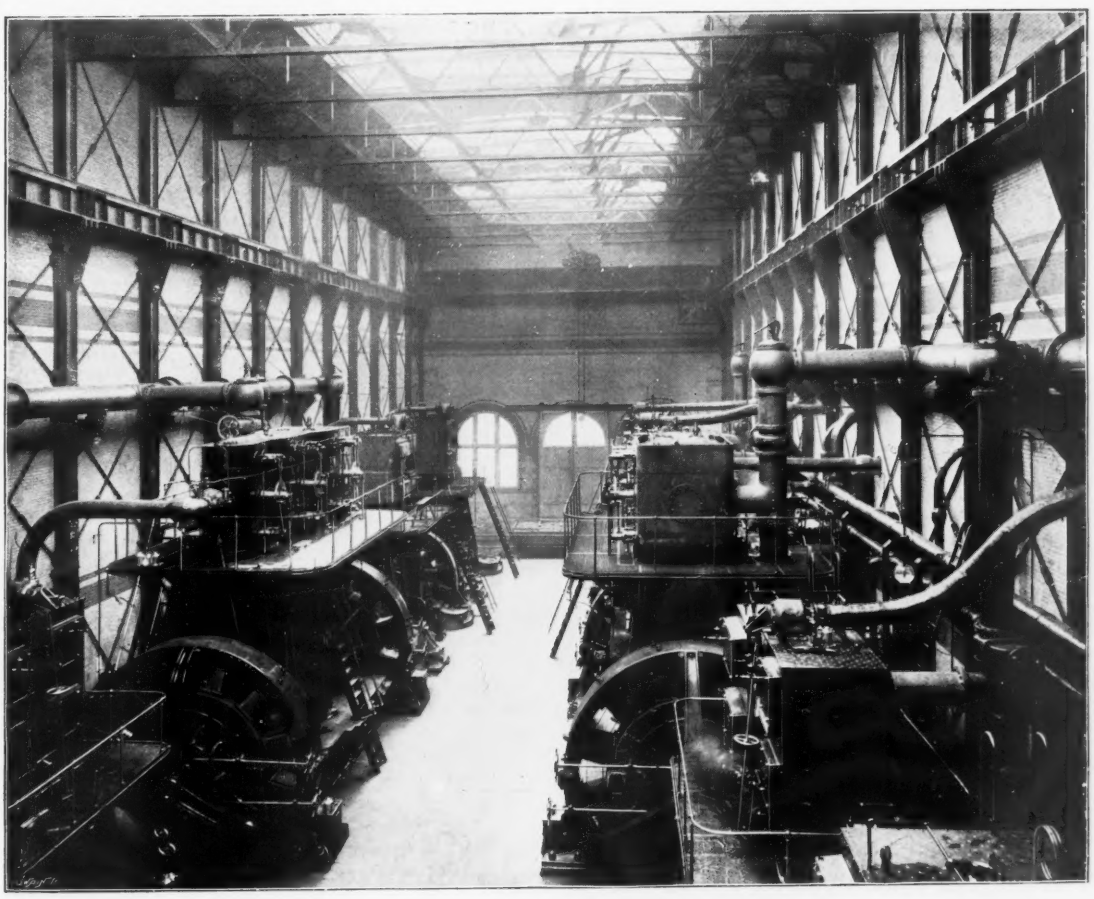
Suffice it to say the Market Street station contains four Thomson-Houston arc light dynamos capable of lighting 165 10-ampere lamps.

Two Edison bipolar boosters of 275 kw. capacity for use on the three-wire system.

The alternating incandescent plant is capable of energising 6,300 lights, and the power supply at 500 volts has a capacity of 392 kw.

The engines are on the ground floor, and drive up by means of ropes on to the second floor, which is entirely devoted to a long line of shafting, friction clutches, &c., from which the machines on the first floor are driven by belts.

The Wabash Avenue station contains low tension plant to the extent of 435 kw. alternating plant and series arc plant. The north side station is far more modern, the plant is all direct connected low tension, and contains four 75 kw. and

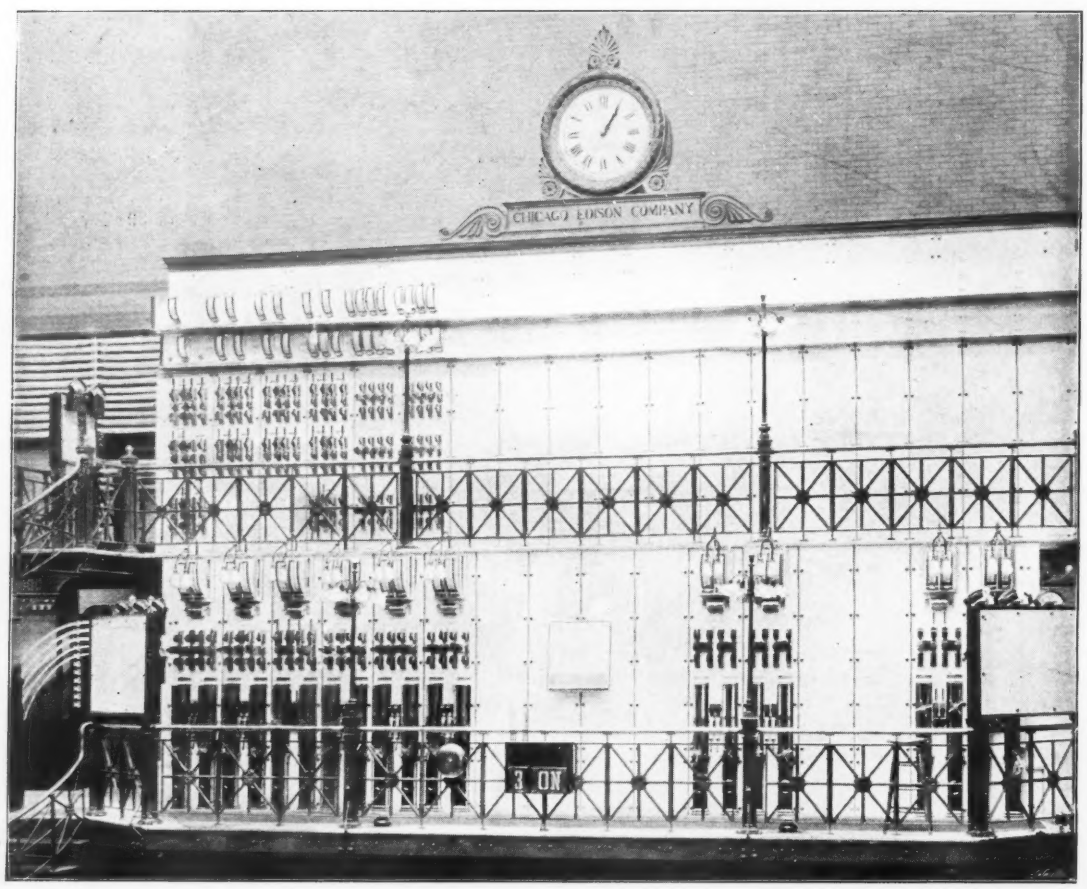


General View of Engine Room.

two 50 kw. Edison multipolar generators driven by the cross compound engines of the Lake Erie Engineering Works of Buffalo.

Turning from these more or less miscellaneous plants, we come to the latest development, namely, the Harrison Street station, by far the most important, and which will compare favourably with any modern station of its kind.

The site, the outcome of much careful consideration, was eventually decided upon on the western side of the Chicago river, the idea being to utilise the river water for condensing purposes, to meet the expansion of the city on the western side, and develop the demand there; it is 3,300 feet from the old Adams Street station, which was abandoned in September, 1894, as a generating place, and is now only used as a distributing centre, the building being used for offices.



SWITCHBOARD.

As to the relative position of these stations, the distance between the north and south side stations is 3¼ miles, and the actual area supplied 15 square miles.

Harrison Street.

The steam generating plant consists of 14 Heine tubular boilers, arranged in two rows, one on each side of the room, each of 500 H.P., with a working pressure of 175 lbs.

At one time oil was used as fuel, but now a slack coal, the cost, including delivery at the station, being 4s. 4½d. a ton; it is brought from the railway station adjoining right into the boiler room on trucks, all the coal being weighed before entering the building.

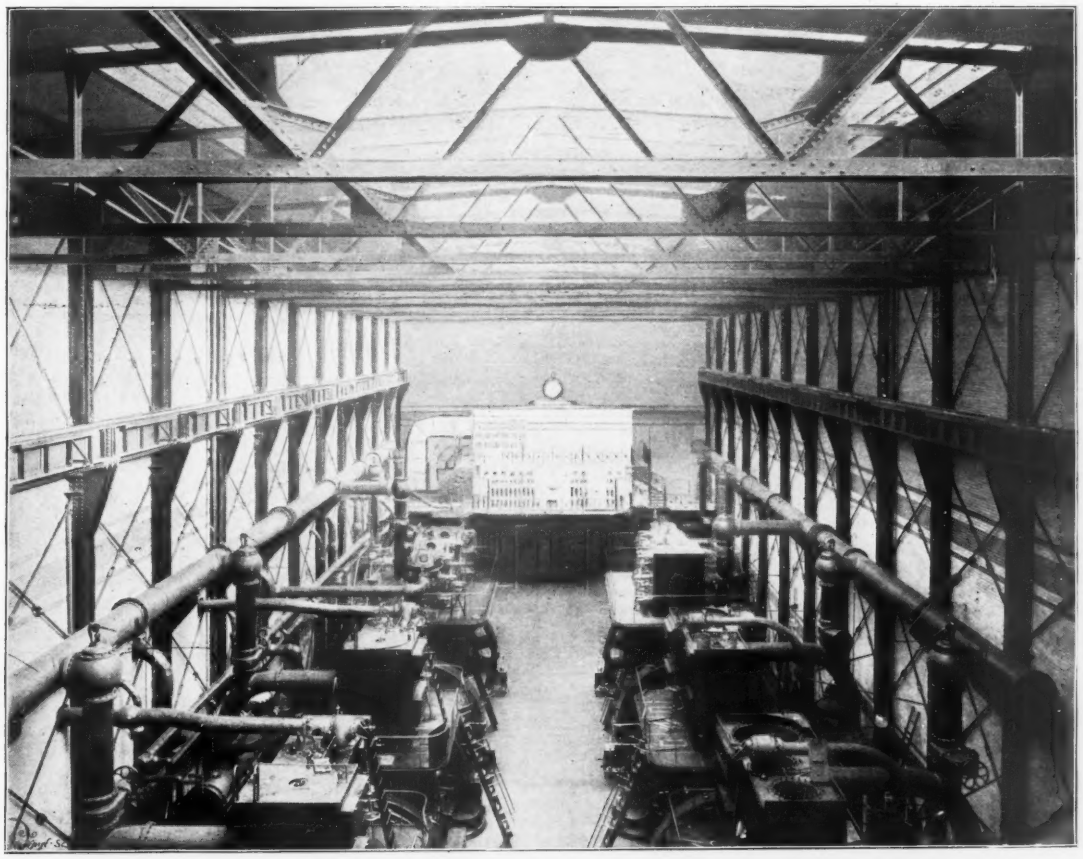
A daily record of both water and coal consumption is kept, which gives an immediate test on the relative evaporative power of any two fuels. For example, the cost of evaporating 1,000 lbs. of water with oil was 8½d.—9d., but by the coal now used is only 3½d.

The water consumption is measured by a counter on a service pump, which pumps the hot well water through a filter to the top of the Worthington feed water heater, and is thence fed, together with the exhaust from the pumps, through another filter into the boilers. The hot well is provided with a float, so that when the water falls below a certain level, it is restored to that level from the condensing water, which is circulated by a compound horizontal Worthington pump.

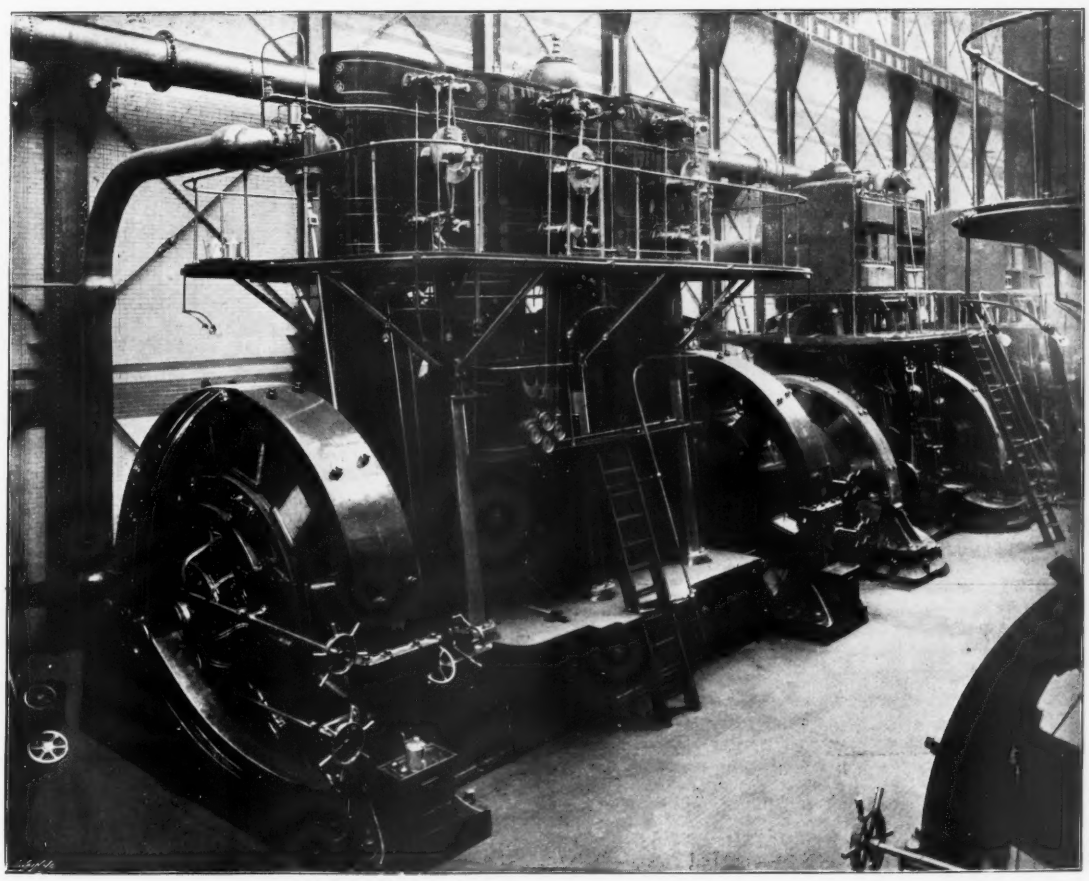
The engine room adjoins the boiler room, and each engine contains in itself a three-wire unit; that is to say, each engine drives direct two dynamos, one connected between the positive and neutral, and the other between the neutral and negative.

Two of them are Edison engines, and the remaining eight are Southwark engines; they are all triple expansion three-crank, and have the peculiarity that the high pressure cylinder is in the middle, and the low and intermediate are on the outside cranks. There are only two bearings, and the dynamos are carried on extensions of the shaft outside the bearings, and practically act as fly-wheels. The arrangement is such that, as you face each plant, the positive dynamo is on the right and the negative on the left, a method which holds good for all collections of switches, instruments, &c., throughout the whole system. The Edison engines are each 1,200 H.P., and have Corliss valves; the four smaller Southwark are 600 H.P., and the four larger 1,200 H.P., and have radial valve gears similar to Joy's, the admission and exhaust being quite independent.

The larger Southwarks have cylinders 20 inches, 30½ inches, and 50 inches, with a stroke of 36 inches running at 128 revolutions. Some recent tests show a consumption of 13·28 lbs. of steam per I.H.P. hour at 1,100 H.P., and 13·53 lbs. at 1,300 H.P.; the cylinder covers only are jacketed, the intermediate and low with a reduced pressure. It is, however, found more economical to run non-jacketed, a result not altogether surprising, since it must be remembered that a large portion of the heat in the low pressure jacket must be expended in uselessly heating the exhaust. The Southwark engines are each provided with a Wheeler surface condenser, the smaller having Worthington air



Engine Room, showing Switchboard at Far End.



Corliss Valve Edison Engine.

pumps, and the larger Blake pumps of the U.S. Navy pattern. The Edison engines contain their condensers in the bedplate with the air pumps worked direct from the engine.

The dynamos are all shunt multipolar General Electric machines, the smaller being of 200 kw. and the larger of 400 kw., and all are designed for 150 volts.

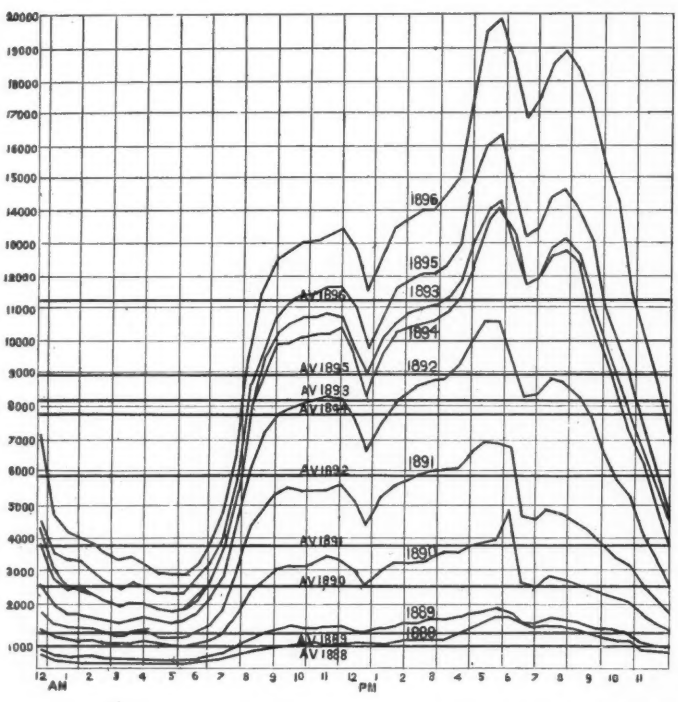
The 200 kw. dynamos are of the "ironclad" type, with a slotted core, the method of winding being the multiple drum.

The 400 kw. machines are ring-wound of the smooth body type, the armature core being supported by a spider keyed on to the shaft. The mains from the machines are led to the switchboard situated, as will be seen from the illustration, at one end of the engine room; it is built in two galleries, and being of white marble is a strikingly handsome piece of work.

The lower gallery is devoted to the machines, each three-wire unit having a panel 20 inches in width allotted to it; there are now ten panels, and the ultimate capacity of the board will admit of 104,000 amperes being handled there. At present the control of 53,000 amperes is achieved in a space of 16 feet 8 inches.

As will be seen from the picture, each panel contains at the bottom two vertical field regulators, one for the negative and one for the positive dynamo; between them is the neutral switch, above this the positive and negative switches, and at the top the galvanometer and galvanometer switches (for paralleling purposes) and two edgewise ammeters, one on the negative and one on the positive dynamo.

The ammeters are 4 inches in width, and are registered to read from 0—2,000 amperes or from 0—4,000 amperes, according to the dynamo to which they are connected; they are all Weston shunt ammeters.



Composite Ampere Curve, Low Tension System, Chicago Edison Company.

Absolute maximum points reached.		Load factor in terms of the average maximum.		Load factor in terms of the absolute maximum.	
1888	2,505	1888	36·9 %	1888	26·4 %
1889	4,755	1889	52·3 %	1889	22·6 %
1890	9,855	1890	59·8 %	1890	25·6 %
1891	16,470	1891	52·6 %	1891	22·9 %
1892	24,640	1892	50·7 %	1892	23·8 %
1893	29 150	1893	51·1 %	1893	28·0 %
1894	32,330	1894	48·3 %	1894	24·0 %
1895	37,860	1895	41·4 %	1895	23·6 %
1896	43,130	1896	42·9 %	1896	26·0 %
1897	...	1897	...	1897	...

At present current is only generated at one potential, but it is ultimately intended to generate at two potentials; therefore there are two sets of busses, a high and a low, and as will be seen, all the main switches are two-way, throwing them up putting them on one bus, and throwing them down putting them on the other.

The method of paralleling is simplicity itself; the switchboard attendant posts up the number of the engine he wants, and calls the attention of the engine man by means of a bell, who signals back by the same means when he is ready: the switchboard man then closes his neutral and the galvanometer circuit, waits till the galvanometer is zero, and then closes the other main switch.

It is so simple that it requires no experience to manipulate; several men can operate at the same time, and there is no chance of the machine coming up with reversed polarity. On the right are voltmeters which indicate the pressure at which two particular feeders feed into the network; these are taken as standards, and it is known that when this voltage is right, the pressure over the whole network is well maintained.

Ample access is given to the back of the switchboard where the bus bars are situated; these are of massive construction, and it is worthy of note that all bus bars, switches, &c., throughout the whole board are of hard wrought copper of 97·5 conductivity.

At every 40 inches vertical connections are made with the feeder bus bars situate behind the board on the gallery above. The standard feeder panel is 20 inches wide, and contains switches for four sets of feeders; the feeders are all three-wire, and each set has two ammeters, a positive and negative, and three switches, positive, negative and neutral, arranged one above the other. The four panels on the left are all devoted to the Adams Street feeder; this has a total capacity of 45,000,000 circular mils, 18,000,000 on the positive, 18,000,000 on the negative, and 3,000,000 on the neutral; the remaining 6,000,000 circular mils has a special panel, the one on the extreme left, so arranged that these cables can be thrown either on the positive, neutral, or negative, as occasion or convenience requires.

All the cables in the station are coated with asbestos, which renders them completely fireproof. A maximum density of 1 ampere per circular mil is allowed in the dynamo mains, and in each three-wire unit the positive terminal of the negative dynamo and the negative terminal of the positive dynamo is connected at the machine, so that there are three leads to the switchboard, which are all of the same size.

By far the greater part of the current generated at Harrison Street is conveyed to the distributing centre at Adams Street by the great feeder mentioned above, a distance of 3,300 feet; it is taken under the river in a brick tunnel in 45 Siemens iron armoured cables of 1,000,000 circular mils capacity, and it is then connected to a distributing switchboard, whence it is transmitted by cables of 3,000,000 circular mils capacity in 15 Edison tubes to Adams Street. Arrived here, the feeders are connected to the bus bars by 15 switches, there being a corresponding device to that at Harrison Street for varying the amount of copper in the neutral.

These bus bars run to the distributing room, a very compact room, with the feeder panels on two sides.

Each feeder panel has a width of 8 inches and contains three switches, positive, negative, and neutral, vertically above each other, and two ammeters, positive and negative. There are 37 feeders, and each will carry 600 amperes, at a maximum load. At the end of the room are the main ammeters and two voltmeters, with a multiple way switch

for connection to the bus bars or any feeder. An attendant is always kept in the room and it is in telephonic communication with Harrison Street.

Nearly all mains and feeders are run in Edison tubes, and in the feeders, which are regularly tested, an insulation resistance of one megohm is aimed at, the neutral is, however practically grounded.

It is exceedingly interesting to note that throughout the whole system there are no fuses, cut outs, &c., of any description except where the feeders enter the network. Connection is here made by a copper fuse, which has been found extremely sensitive. Yearly average load curves, show the steady advance made by the company, the apparent discrepancy in that 1893 is higher than 1894 being accounted for by the fact that 1893 was the Exhibition year.

Another remarkable fact in connection with this system is that despite the somewhat extended area of supply there are no battery sub-stations, and the future development will be very interesting to low tension lighting engineers in that Mr. Ferguson the electrician has devised a scheme which will avoid the use of batteries altogether.

The problem before the company is that there are indications that nearly the whole lighting in the future will be done on the three-wire system, the area ultimately to be supplied is very large, and the load curve is good; that is to say, for a fair number of hours during the day there is a good load.

To solve the problem the idea is to concentrate the steam plant at two centrally-situated stations, namely, Harrison Street and Market Street, and use the outlying stations merely as transformer sub-stations. This is to be effected by having at the central station a direct driven machine, a view of which is shown, with a commutator at one end and three collector rings at the other, the winding being tapped in three places so that you can take off three-phase alternating current from the rings.

The direct current voltage is to be about 230, so that it can be supplied to the outside "wires," and the alternating will then be about 160. This is to be transformed and transmitted at high voltage, transformed down at the sub-station to 80 volts, passed through a rotary transformer, and supplied to the mains as direct current at 120 volts.

Assuming that at full load the efficiency of each transformer is 97·5 per cent, that of the rotary transformer 91 per cent., and line loss 5 per cent., the total efficiency, not including generator losses, would be about 82 per cent., and at an average load of 40 per cent. maximum, it would be about 78 per cent.

It is estimated that the cost of installing this plant, including mains, &c., is about equal to that of a battery which would be laid down under the same circumstances with a two hours' discharge.

Taking into consideration the fact that the load is well maintained for several hours, the system just described will be considerably more efficient than a battery of this capacity, and it has the added advantage that it is capable of excellent regulation, and it is always possible to keep the units at the central station at full load.

So much for the future; the company is now in a very prosperous state, and sells current at the rate of 10d. per kilowatt hour, a discount being allowed, based on the number of kilowatt hours consumed per lamp per day; the maximum discount is such that the lowest rate is 4½d.

As is customary in America, the lighting company test, supply, and maintain all lamps, both incandescent and arc, and this fact must be borne in mind in making comparisons between English and American stations.

Before closing this article, we must express our very sincere thanks to Mr. Insull, Vice-President, and Mr. Ferguson, the company's electrician, for the very kind way in which every information was placed at our disposal.

BUSINESS NOTICES, &c.

(*Continued from page* 880.)

Dublin.—The contract for electric lighting in connection with the New Star Theatre of Varieties, Dublin, has been secured by Messrs. Hanley & Shanks, of Cork. The firm has opened new showrooms and offices at Dawson Chambers, 18, Dawson Street, Dublin, owing to increased business.

Dissolution of Partnership.—Messrs. E. G. Pulford and E. C. D. Bisserot (carrying on business as electrical engineers at Liverpool under the style or firm of Pulford, Bisserot & Co.) have dissolved by mutual consent, as and from March 31st, 1897. Debts will be attended to by Mr. E. G. Pulford, who will carry on the business.

Messrs. Oswald R. Swete and Basil R. Baker, trading under the style of Swete & Baker, electrical engineers at Johannesburg, have dissolved partnership mutually from May 24th. Mr. Baker has taken over the business, and will settle the liabilities of the late firm.

"Trusty" Engines.—The "Trusty" Engine Works had, at the Royal Agricultural Society's Exhibition at Manchester, an attractive show of their well known engines, showing amongst others 3½, 9½, and 25 H.P. fixed, and 9½ and 18½ H.P. improved portable oil engines, and 1 and 10 nom. H.P. gas engine, and an electric light installation (by Drake & Gorham), driven by one of the larger engines. This company inform us that during the last 12 months they have supplied a large number of their engines for such installations both at home and abroad, and at the present time several important contracts are in hand for lighting country houses. The successful use of these engines (which are now manufactured in all sizes, single cylinder, from ½ to 40 H.P.) for general farm and estate purposes, is leading farmers and others to replace their steam engines, horse gears, and turbines by them. Since the last Royal Show, some important contracts have been completed for the South American, Japanese and Norwegian Governments, and the leading home and foreign railways, and at the moment a large pumping contract is being put down for one of the leading railway companies. The 25 H.P. oil engine exhibited was a compactly designed engine, and one largely used for electric lighting, pumping, sawing, &c., and also for use on the goldfields, and as the consumption of oil per horse-power per hour is very low, the economy effected as compared with steam or other power is considerable. The 3½, 6½, and 9½ H.P. types of portable engines have a self-contained water tank in the frame of engine, thus obviating any cartage of water for cylinder purposes. The weight of these engines is said to be nearly 50 per cent. lighter than steam engines of equal power. The company has issued a new illustrated catalogue of these engines.

ELECTRIC LIGHTING NOTES.

Bedford.—The installation of the electric light in the Town Hall and the adjacent buildings is to be completed, and the electrical engineer is to carry out the work.

Bradford.—The Bandstand, Conservatories, and Promenades at Lister Park are to be fitted up for electric lighting at a cost of £260, the Park Band Committee to contribute £100 of the cost.

Cambuslang.—Arrangements have now been completed for the introduction of the electric light in Cambuslang. The contract has been given to Messrs. Hunter & Jack, electrical engineers, Glasgow, who are to put down a plant at the gas works capable of running 20 arc lamps of about 2,000 C.P. each. In the meantime only the main street is to be lighted, and for this purpose 12 lamps will be required. It is expected that the installation will be completed by September 1st next.

Darlington.—A lengthy letter in the *Northern Echo*, signed "*Stat Nominis Umbra*," argues against the purchase of the gas works, and quotes the experience of many provincial cities as evidence that it is time that Darlington Council went in for municipal electric lighting. He says that various large establishments are putting down private plants, because there is no public supply.

Dundee.—An electric light installation has been completed in Free St. Paul's Church, Nethergate.

Glasgow.—At the last meeting of the Corporation, Mr. Maclay moved the adoption of the minutes of the Electrical Committee. They said that a deputation from the committee had a conference with the Tramways Committee, and offered to supply them with the current they wanted, to give them at all supply, and, at the same time, they undertook to give it at as low a rate as they could develop it for themselves, and probably at a lower rate. He was sorry to say that he had learned in an informal way that the Tramways Committee were not favourable. The minutes were approved.

Gloucester.—Mr. Robert Hammond has been appointed consulting electrical engineer to the city. His first duty will be to report to the Electric Lighting Committee upon the general question of electricity supply for lighting and other purposes, and upon the advisability of the Corporation establishing works in conjunction with refuse destruction.

Hammersmith.—The Electric Light Committee is notifying the public that a supply of current will be available for private consumers on and after July 1st.

Islington.—The Vestry has referred to the Electric Lighting Committee to consider and report: (1) What particular area in the parish should be included in the next extension of the electric lighting system? (2) When it would be desirable to proceed with such extension? and (3) the estimate of the probable cost of such extension.

Kirkby-in-Ashfield.—The estimate of Mr. F. J. Farse for lighting the parish with electricity was discussed at the last Council meeting, and it was agreed to postpone the matter for the present, and to ascertain in the meantime the cost of lamps, &c., for the lighting of Kirkby and East Kirkby with gas.

Llandudno.—A long report was presented at the last Council meeting by Mr. A. H. Preece on the question of electric lighting, and the provision of electric power for the proposed tramways. He recommended that notice should be sent as early as possible to the Local Government Board to obtain their sanction to a loan; that specifications of all the buildings, machinery, and mains should be prepared forthwith; that tenders should be obtained as early as possible for all the engineering work at any time; that, independently of any inquiry, the tenders should be reported upon, and those approved accepted, subject to the loan being sanctioned; and that as soon as the sanction had been obtained the contracts be sealed, and the work started. The estimated cost was set down at £24,891, and was sub-divided as follows:—Destructor works, £6,416; electric light, £18,475. The report was adopted, and it was agreed to ask the Local Government Board to sanction a loan of £25,000.

Larne.—The Town Clerk received a letter from Mr. F. J. Warden-Stevens offering to act as electrical adviser for a stated fee. The Commissioners, after going into the matter, resolved that a competent electrical engineer or expert be employed to inspect and report on the best and most economical means of lighting the town.

Leamington.—The Midland Electric Light and Power Company has notified the Council of its intention to apply for a provisional order. The matter will be considered in committee.

Lourenço-Marques.—A company has just been formed in Paris (50, Chaussée d'Antin) with a capital of £34,000, to be known as the Compagnie Générale d'Electricité de Lourenço-Marques.

Maidenhead.—The Maidenhead Town Council have received a letter from Messrs. Pritchett & Gold, of London, asking if the Council would be willing to consent to their application for an electric lighting provisional order; but the Council intends to apply for a provisional order on its own account.

Mannheim (Germany).—Consul Ladenburg, in a report to the Foreign Office on the trade of Mannheim in 1896, says:—"Electric illumination promises to be a blessing to the workpeople in the factories of Mannheim, especially in the short winter days, and it is being gradually introduced even into small factories, where it is comparatively costly, it being recognised that the capacity of the workman, and the quality of the work, increases correspondingly with the excellence of the illumination. Dining halls in the various factories, well warmed and lighted, are becoming frequent. The inspectors of factories in Baden hold regular 'sprech stunden,' or hours when the workmen can meet them, and speak freely of whatever matter they have to complain."

Portobello.—Prof. Kennedy has sent a report on the electric lighting of Portobello to the Edinburgh Town Clerk. He says:—I do not know to what extent the question of street lighting in Portobello is to be considered, but if, besides this private lighting, the line from the station to the sea were lit with arc lamps, the Promenade itself, and the High Street, the lamps being placed about 70 yards apart, there would be required about 36 arc lamps in all. From whatever point in Edinburgh the current is to be supplied, there is no doubt that it would have to be supplied at high pressure, for otherwise the cost of mains will be disproportionately great. Portobello would therefore be supplied from some station in exactly the same way as the northern and southern suburbs of Edinburgh are now supplied from Dewar Place, and by exactly similar machinery. The fact that Portobello is 3 or 4 miles away instead of being only a mile and a half practically does not make any electrical difference in the case, although it somewhat increases the proportional cost of mains. Considering only current for private lighting in the first instance, I find that the total cost of supplying and laying the necessary high tension cables as feeders, low tension distributing mains, with all road work, transformers and transformer sub-stations, as well as meters and connections for, say, 50 consumers, will be about £7,500. This does not include any machinery of any sort, as it is certain that the supply to Portobello would have to be simply a portion of the general work of the station it was supplied from—no special machines would have to be put down in the station for the purpose of supplying Portobello and doing nothing else. The 4,000 lamps wired may each be taken as using 15 units per annum, making a total of 60,000 units sold per annum. Of course, this is estimating at a very much lower figure than in Edinburgh, where, largely on account of the public lamps, each lamp used in 1896-7 as much as 26·6 units per annum. But it would not be safe to take nearly so high a figure for Portobello. The cost of supplying this amount of electrical energy may be estimated as follows:—

	Per unit sold.
Generating expenses per unit sold, say	1·0 pence.
Capital charges:—5 per cent. for interest and sinking fund on an amount of £7,500 is equivalent to	1·5 „
Maintenance and attendance in connection with the mains may be estimated at £375 per annum, which is also equal to	1·5 „
The value of the plant used in the station for supplying Portobello would be about £2,000, and an allowance of 5 per cent. for interest and sinking fund on this capital would amount to ...	0·4 „
The total cost per unit sold in Portobello, including all capital charges, would thus be abont	4·4 „

Prof. Kennedy also discusses the advisability of a second electric station for Edinburgh, and indicates that if the same progress in extension be maintained, another station will be necessary in eighteen months.

Sofia (Bulgaria).—It is stated that the municipal authorities of Sofia have cancelled the agreement with Messrs. Ganz and Co., of Budapest, with reference to the electric lighting of the town, and that new tenders for a 50 years' concession will shortly be invited.

Marylebone.—The Electric Lighting Committee reported at the last meeting of this vestry with reference to a communication from the Board of Trade, forwarding a description of an additional system by means of which electric energy is to be supplied in the parish under the Metropolitan Electric Supply Company (West London) Lighting Order, 1889. The vestry decided to inform the Board of Trade that they found that the proposed system involved the erection of a transforming station in Marylebone Passage, in the parish, and the construction of brick chambers of 2 feet × 1 foot 3 inches internal measurement under the public footways at very frequent intervals, one chamber being required for the connections to every two houses supplied, but that if the Board of Trade considered the system desirable in the interests of the public, and that the chambers were an essential of the scheme, the vestry did not desire to offer any objection thereto.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birkenhead.—The Town Council last week rejected the recommendations of the Special Tramways Committee. This Committee visited other towns, and inspected electric tramways there, and the majority were in favour of entering into a scheme with Mr. Ross, of Birmingham, who offered to work the lines on the trolley system. Two other schemes (those of Mr. Mason and the Simplex Electric Conduit Tramway Syndicate) were considered, but that of Mr. Ross was favoured. He proposed to give the Corporation a rental of £1,600 a year, and to keep the rails in repair, as well as to reduce the fares. The Council rejected the proposals by 33 votes to 12.

Brompton and Piccadilly Circus Railway.—The Vestry of St. James's, Westminster, at the last meeting considered a letter received from Messrs. Blunt & Co., Parliamentary agents for the Brompton and Piccadilly Circus Railway Bill, intimating that as the Vestry agreed to clauses with the promoters of this Bill in the House of Commons, they were instructed to ask that the Vestry would now support the Bill before the Committee of the House of Lords by sealing a petition in its favour. The Vestry decided to take no action in the matter.

Dundee.—The burgh engineer has reported at length on the municipalisation and extension of the tramway system to the districts of the city not served by the present lines. The question of mechanical power is mentioned briefly, but that point remains to be fully gone into. Ex-Provost Brownlee reported on the negotiations with the Tramway Company.

Dudley.—A deputation from the various local authorities in the Dudley district of the Black Country paid a visit to the Isle of Man at the latter end of last week, when they were accompanied by Mr. Sellon, C.E., of London, for the purpose of inspecting the electric traction at work on the Douglas and Laxey Electric Tramway, it being proposed to convert the steam tramways in the Dudley district into an overhead electrical system. The members of the deputation appeared to be very strongly impressed with the advantages of the electric system.

Dover.—A Local Government inquiry was held at Dover on Saturday respecting the application of the Corporation to borrow £31,000 for municipal electric tramways. There was no opposition to the scheme.

Ramsgate.—At a meeting of the Town Council last week it was decided by 13 votes to 1 not to further oppose the Light (Electric) Railway scheme in that place.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Grenada-Trinidad ...	June 2nd, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian lines.		
Blagowestschensk-Khabarowka	June 18th, 1897 ...	...

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897. — The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

June 3rd, 1897.—During the interruption of communication with Trinidad and Demerara telegrams are sent by hired boat. Delay about 24 hours.

June 17th, 1897.—Telegrams in code are again accepted for offices in the interior of Peru; they are, however, subject to Government control.

The cable connecting Ampenan, Lombok and Singaradja, Bali, both in the Dutch East Indies, is now open to the public.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—July 1st. The Corporation want tenders for the supply and erection of pumps, steam exhaust and feed pipes, &c. Electrical Engineer, Mr. V. A. H. McCowen.

Belgium.—July 2nd. Tenders are being invited until July 2nd next, by the Municipal Authorities of Ghent, for the establishment of an electric tramway in the town. Particulars may be had from the Secretariat, while tenders are to be sent to Le Collège Echivinal, Ghent.

Denmark.—June 30th. The Electric Light Committee of the Municipal Council of Copenhagen are inviting tenders for the supply of about 15,000 incandescent lamps. Particulars from 30, Gothersgade, Copenhagen.

France.—July 13th. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply of 755 kilometres of paper-insulated electric cables in 16 lots. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Halifax.—June 30th. The Tramways Committee are inviting tenders for the supply of steel rails, fishplates, and soleplates for about four miles of single line of tramway, also for the supply of wrought-iron tie-bars, washers and nuts, fishplate nuts and bolts, sole plate nuts and bolts, and lock bars, for the same length of single line tramway. Specifications from Mr. Edward R. S. Escott, C.E., Borough Engineer, Town Hall, Halifax.

Leyton.—July 5th. The District Council want tenders for the supply of stoneware conduits. Electrical Engineer, Mr. H. C. Bishop. See our "Official Notices."

Lincoln.—July 14th. Tenders are being invited for the supply and erection of two dry back marine-type boilers: high-speed engines, continuous current dynamos, steam and other pipes, pumps, motors, and travelling crane; a fuel economiser: storage batteries; a main switchboard and instruments; armoured concentric and triple-concentric cables, and pilot wire cables. Particulars may be obtained at the office of Mr. C. S. Vesey Brown, city electrical engineer, Corporation Offices, Silver Street, Lincoln.

London.—July 8th. The Metropolitan Asylums Board want tenders for the supply and running of mains in the grounds, and for the wiring of the Nurses' Quarters now in course of erection at the North Western Fever Hospital, Haverstock Hill. See our "Official Notices" for further details.

Neath.—June 28th. The Neath Corporation are inviting tenders for the working, by horse or mechanical traction, of the existing line of tramways.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Spain. — July 12th. The General Direction of the Spanish Posts and Telegraphs in Madrid is inviting tenders for the supply of 20,000 sheet zinc cylinders. Tenders to La Direccion General des Postes y Telegrafos, Madrid.

St. Helens.—July 20th. The Corporation want tenders for the supply and erection of plant and machinery for electric lighting extensions, including boiler, pump, economiser, alternators, exciters, switchboard, underground work, transformer sub-stations, &c. Consulting engineer, Mr. Robert Hammond. See our "Official Notices."

CLOSED.

Austria.—Messrs. Ganz & Company of Budapest have secured the contract for the construction of a municipal central station at Trieste.

Brighton. — The following is a list, taken from the *Contract Journal*, of the tenders sent in for the completion of the electric light wiring, &c., of the Municipal School of Science and Technology, Richmond Terrace, Brighton, for the Council. Note:—If in wood casing, with the exception of the basement and other situations mentioned in the schedule.

W. Lucy & Co., Ltd., Oxford	£571 0 0
Belshaw & Co.	835 0 0
Fowler, Lancaster & Co., Ltd.	665 17 9
J. H. Pickup & Co., Ltd.	639 14 2
Page & Miles, Brighton (accepted)	569 15 0
If in insulated iron pipes throughout.	
Globe Electrical Co.	£997 0 0
W. J. Fryer	814 17 4
Bergtheil & Young	1,257 14 0
Lloyd & Read	546 0 0
Laing, Wharton & Down, Ltd.	875 0 0
Laing, Wharton & Down, Ltd.	855 0 0
W. Lucy & Co., Ltd.	646 0 0
Belshaw & Co.	1,010 0 0
J. H. Pickup & Co., Ltd.	739 16 7
Page & Miles	740 0 0

Belfast.—The Edison & Swan United Electric Light Company have secured a contract for arc lamps from the Corporation. Messrs. Crompton & Co. are to supply the motor generators, &c., and Messrs. Victor Coates & Co. the automatic stokers.

Paisley.—The Council has accepted, in accordance with the Electric Light Committee's recommendation, the tender of Messrs. Fullerton, Hodgart & Barclay, to supply certain cranes at a cost of £246, also cast-iron brackets. The offer of Messrs. Callender's Cable Company to complete the proposed extension through Calside and Castlehead, a distance of 3,177 yards from Johnstone Street to Castle Street, for the sum of £1,600. Mr. Teague has submitted plans of the proposed electric works at Blackhall.

Roehampton.—The contract for fitting up, for electric lighting, the Holy Trinity New Church, Roehampton, has been given to Messrs. Laing, Wharton & Down, Ltd., at £151. There were six tenders altogether, this being the lowest.

NOTES.

Marriage.—We learn that Mr. Philip F. W. Simon, of Simon, Berry & Co., was married on 15th inst. to Miss Lucy Annie Chandler of Enfield.

Appointment Vacant.—The Morecambe District Council is inviting applications for the post of resident electrical engineer, at £175 per annum. See our "Official Notices" for further details.

The Jubilee Honours' List.—We are glad to note in the Honours' List the following names, as the owners, in their different spheres, have contributed to the extension and development of electrical undertakings. We give each recipient his new designation:—Sir James Pender, Bart., M.P.; Sir Cuthbert Quilter, Bart., M.P.; Rear-Admiral Sir W. G. L. Wharton, K.C.B., F.R.S.; Sir Sandford Fleming, K.C.M.G., &c.; Sir William Crookes, F.R.S.; A. S. Thomson, Esq., C.B., Lieut. R.N.R.; C. H. Reynolds, Esq., C.I.E.; B. Trail Finch, Esq, C.I.E. We are also pleased to notify the fact that Dr. E. Frankland, F.R.S., who is so well known to electrical men as the inventor of a storage battery plate, is on the list for knighthood.

The Electrical Illuminations. — In the unparalleled illuminations of the present week in London, and also in the suburbs and provinces, electricity has been employed with excellent effect. It is unnecessary to refer in detail to every building illuminated in this way. £1,400 odd was spent for illuminating the dome of St. Paul's Cathedral by means of 70 projectors of 2,000 C.P. each. The work of Messrs. Faraday & Son at the Athenæum Club, Messrs. Pears's premises in Oxford Street, and various West End mansions, was evident; also that of Messrs. Cunnington and Co., at the Adelaide Gallery, and that of Messrs. Rashleigh, Phipps & Co. at Messrs. Mappin Bros., Liberty & Co., and other large business establishments in the City and West End.

The premises of the Sun Fire Insurance Company were fitted up and decorated by the Electrical and General Engineering Company (who have taken additional offices at 17, Gracechurch Street, E.C., where all communications should in future be addressed), about 20,000 C.P. being employed. The same company also illuminated the premises of the Equitable Insurance Company, the City Bank (Ludgate Hill), the Belvedere, Pentonville, N., the White Hart, Strand, the Yokohama Specie Bank, and other buildings.

Unfortunately there were slight fires in one or two directions, said to be caused by the electrical wires.

Economy due to "Economisers."—When an engineer who is supposed to have experience in steam raising makes statements such as that reported to have been recently made by Sir Frederick Bramwell, to the effect that with properly proportioned boilers the "economiser" was unnecessary, it becomes necessary to either accept the dogma, or to ask "did Homer nod." We think he did; at least, all experience points to stage heating as the only means of properly reducing the temperatures from high pressure boilers, if not from boilers at low pressures. We are all so accustomed to the Green type of economiser that we have ceased to make special tests of its working. In America, the economiser is of but recent introduction, and there is some excuse for making tests of the apparatus to find if it effects the economies with American practice that it does here. Tested in Toronto by Mr. Barrus, in the Toronto Railway Company's house on August 21st and 22nd last, it was found to save 18·3 per cent. of fuel. There are six marine Scotch boilers at this place, and full particulars are given, which it is not necessary we should reproduce from the *Street Railway Journal*, which publishes the figures. The trials lasted nearly 20 hours each, and coal was burned at 22·4 and 24·5 lbs. per foot of grate per hour, with and without economiser. The feed was raised from 101° to 237° in passing the economiser. The gases were reduced from 620° to 293°, the evaporation per pound of coal was raised from 6·731 to 8·275, and as stated an economy of 18·3 per cent. was secured, which means over 10 tons a day. Similarly the South Chicago City Railroad using oil fuel saved 15¾ per cent. by the use of an economiser. The St. Charles Street Power House in New Orleans finds an economiser to raise the feed from 200° up to 270°, the gases leaving the economiser at 290°. Another test showed the feed to enter at 202° and to leave at 274°, the gases dropping from 480° to 300°. Here the economy is marked, although the feed is raised to 200° by auxiliary feed heaters prior to entering the economiser. Other stations also report satisfactorily, the Detroit Railway Company finding 16 to 20 per cent. of saving, and it is summed up that the economiser will save from 12 to 20 per cent., or, say, 1·2 to 1·4 per cent for each 10° of temperature added to the feed. These figures are fairly representative of English findings, and seem to confirm the economy of stage heating. At least they show that if Sir Frederick is right there must be a huge field for the Bramwell boiler. Puzzle! find the boiler.

The Kinetic Motor.—The *Street Railway Journal* publishes a description of a so-called kinetic motor which has been running a short time on a New Jersey railway. It is simply a modification of the Lanin Francy motor. The modification consists in the addition of a small furnace to the hot water storage. The tramcar carries at its rear end a boiler of tubular type, of a capacity of 275 gallons, which is put in at 200 lbs. pressure. There is a fire box with a grate 20 inches × 30 inches, filled up with anthracite coal. About 4 lbs. of this is burned per mile, and this not only compensates for all radiation losses, but raises some additional pressure on long stops or down hill. The engines of this car have 9-inch cylinders, 10-inch stroke, connected directly to 30-inch wheels, and there is an air condenser of 1,600 square feet air surface. The total weight is 29,000 lbs., ready for work, and the capacity per charge 20 to 30 miles, and a trailing car of 33 tons is easily drawn over long and steep grades, the evaporation being then at the rate of 38 lbs. per mile. It is said that the cost per mile with trailer should not be over a halfpenny. Full boiler pressure is not used in the cylinders, a reducing valve being employed. The fire is not attended to during the trip. It is not a little strange that in America, where electric traction has been so much developed, there should still be so many other motive powers tried on traction work.

Personal.—We understand that Mr. W. Geipel, M.I.E.E., has resigned his position as superintending engineer of the Brush Electrical Engineering Company, in whose service he has been for 15 years, in order to enter into partnership with Mr. F. M. T. Lange, A.M.I.C.E., M.I.M.E., M.I.C.E. (France), nephew of the late Sir Daniel Lange, C.E., &c., of Suez Canal fame. These gentlemen have purchased the Westminster business of Messrs. Paterson & Cooper, which they intend to carry on and extend.

Mr. Preece as a Worker.—The *American Electrician* says that in a recent interview Mr. Herbert Laws Webb quoted the following answer of Mr. Preece in reply to a query as to how he managed to accomplish so much work as he is known to do in one day. "Well," he replied, "I always go to bed regularly at 11 o'clock at night, and I always awake regularly at 4 o'clock in the morning. Before I gave up smoking I was always drowsy on awaking. I stopped smoking seven or eight years ago, and now I wake instantly and am ready for work. I sit up in bed and put in from four to seven hours at whatever I have in hand. It is a splendid way of adding 40 per cent. to the working day." "Whatever he has in hand" may be the process of a new invention, a monograph on some scientific subject, or an argument on ocean telephony. Nearly all his original papers were written in this manner. But when he goes to the Post Office he endeavours to forget his early morning work, for the time being at least. The evening is generally put in in lecturing, or at the meeting of some scientific society.

Precarious Play.—Some Syracuse lads indulged in some "fun" with live electric wires last month. A wire which had been employed as a guy to support an electric light pole had come down and crossed a live wire in falling. The boys attached it to a piece of barbed wire from a neighbour's fence, and laid the latter across the cycle path, from which wheelmen would attempt to remove it in passing and receive a shock. Another trick was to throw it over a trolley wire, making a short circuit and stopping the cars. One boy, barefooted, playing about the spot, grasped the wire, and ran his hand swiftly across a point where the insulation had worn off. He was standing with bare feet on the tracks of a disused trolley line at the time. The boy died in about eight minutes. He had received a shock from about 2,500 volts.

Tesla's Transmission without Wires.—Mr. Tesla announces in an American journal that by his well known system of transmitting intelligence by means of electrical "resonance" between points widely apart, without any connecting wires, he has lately been able to signal 20 miles. Mr. Tesla confesses, says the N.Y. *Electrical Engineer*, that the system is still liable to break down in bad weather, but such results will doubtless encourage him to persevere until the distance is many times greater, and the method is quite independent of disturbing atmospheric or terrestrial effects.

The Naval Review.—A special naval issue of the *Indian and Eastern Engineer* has been published to commemorate the Diamond Jubilee of the Queen. It is most elaborately got up, and is a work of art. Engineering progress in India and the East during the Victorian Era, 1837—1897, forms the subject of two articles. An article on the "Naval Review of 1897" is well illustrated.

Arc Lighting from Street Centres.—L. M. King, superintendent of the Merchants' Association, San Francisco, has recently completed an extensive report and plan for a general system of lighting this city by electricity, the additional cost of which, he claims, would not be more than $5,000 per annum. The leading principle of this system is that of suspending an arc light in the centre of each crossing of all the business streets of this city, and dispensing with the adjacent gas lamps, which will thereby become unnecessary. The cost of this system of lighting would not, in Mr. King's opinion, be more than $5,000 greater than the present gas illumination. He figures, says the *Electrical Engineer* of New York, that in certain thoroughfares one electric light would displace four gas lamps. According to the present contract these gas lamps cost 48 cents a night, and the electric light would cost 55 cents per night. The total number of electric lights required for this schedule is 281, and the number of gas lamps that would be displaced is 1,042. This would make the cost of 281 electric lights, at 55 cents each, $154.55 per night, and there would be a saving of 1,042 gas lamps, at 12 cents each, amounting to $125.04 per night, which makes the total increase of cost only $29.51 per night. These figures, however, Mr. King says can be materially reduced, and the actual additional cost would not be more than $5,000.

Institution of Junior Engineers.—By invitation of Prof. J. A. Ewing, Professor of Mechanism and Applied Mechanics at Cambridge, a party of this institution will visit the Engineering Laboratory of Cambridge University on the afternoon of Saturday, July 3rd.

The Mordey Winding for Armatures.—Writing to our esteemed contemporary, the *Electrician*, on the subject of Mr. Mordey's paper, Mr. W. B. Sayers says:—"Since the discussion on Mr. Mordey's paper it has occurred to me that the explanation of the improved results obtained by Mr. Mordey with his new winding applied to the 15-kilowatt machine is largely contained in my contribution to the discussion on his paper. The self-induction of a section being proportional to the square of the number of turns in one slot undergoing simultaneous commutation, it follows that by dividing the four-turn coil into two equal parts, disposed in slots distant from each other, the self-induction of the coil will be halved, while at the same time half the conductors will be available for commutating power. On this account, therefore, the ratio—commutating power to self-induction—remains the same. But the leading horn will be stronger with Mr. Mordey's winding on account of back-turns being non-existent, thus giving an advantage in favour of Mr. Mordey's arrangement. When the same reasoning is applied to the case in which he puts only one turn forward and three back, it is found that instead of halving the self-induction he only reduces it in the ratio of 16 to 10, while the commutating power is quartered. It is possible with a large gap between the poles that the magnetising turns on the armature should keep the leading horn up to a strength several times as great as would have been the case had all the turns lying between the poles been back turns, and this apparently was the case in the machine upon which Mr. Mordey made his experiments."

The Electrolytic Manufacture of Alloys.—A new process has been worked out by J. Heibling, of Grenoble, in which alloys are produced electrolytically if they possess an iron base, taking advantage of the well-known fluxing properties of carbon and lime. The chief alloys covered by this process are ferro-manganese, ferro-chrome, ferro-luminium, and ferro-nickel. The process is carried out in a furnace which is partly cylindrical and partly conical, and is constructed inside of carbon and outside of fire-bricks, and has at its bottom a movable bed-plate, preferably formed of fusible cast-iron, which is intended to be melted during the operation. This bed-plate rests on another, also movable, which is formed of carbon bricks, produced by baking a suitable mixture of pulverised coke, plumbago and tar in closed cast-iron moulds. This furnace acts as a negative electrode, the positive consisting of a bar of carbon, the size of which depends on the depth of the furnace and the electrical energy available. The powdered ore or oxide to be treated is mixed with a quantity of carbon equivalent to the oxygen in the ore and as a flux, has incorporated with it a variable quantity of powdered quicklime, together with a further proportion of carbon. If the nature of the ore admits of it, an oxide of iron is added, together with a quantity of carbon necessary to effect its reduction, so as to obtain the required alloy, the weight of the cast-iron plate being taken into account. If the silicon present be in excess of the current, the ore and oxide of iron are reduced, and calcium carbide is formed by the mutual action of the calcium and carbon dissolved in the iron alloy. To remove the product, the carbon bed-plate is lowered on one side by suitable mechanism. The carbide of silicon present in the calcium carbide slag renders the latter more proof against the action of moist air than would otherwise be the case. An excess of silica is to be avoided.

The Extraction of Gold from Cyanide Solutions.—S. Creasdale, after a large number of experiments conducted on a commercial scale, has come to the conclusion that the most advantageous method for the recovery of gold from cyanide solutions was electrolytic precipitation, using amalgamated zinc plates for the positive electrodes, and sheet lead for the negative electrodes. Zinc was chosen on account of its efficacy in precipitating gold from cyanide solutions, and its price not placing it beyond a commercial possibility. The strength of current used was 0·04 to 0·05 ampere per square foot of depositing surface. The voltage was not determined, but was very low. The flow of solution through the precipitating tanks was such that each square foot of depositing surface received the gold from half a pound of solution in 30 seconds. In three experiments the gold extraction was respectively 95·50, 99·56 and 99·06 per cent., and experience proved that these results could be obtained day after day without difficulty. With lean solutions the flow of solution through the tanks was doubled, and an extraction of 93·48 per cent. was obtained. The zinc plates at the end of the experiments showed little or no wear. The destruction or loss of cyanide in the experiments referred to was as follows: (1) 8·78 per cent.; (2) 2·60 per cent.; (3) and (4) none. The cyanide solution, as it came from the precipitating tanks, was remarkably active in dissolving gold, due no doubt to the presence of nascent oxygen, which makes it especially valuable for treating the next lot of ore in the leaching vats. This increased solvent action was fully as great as that produced by the addition of sodium peroxide, &c., to ordinary cyanide solutions, whilst the destruction of cyanide was apparently not so great.

Electrical Companies in Germany.—A Berlin "special" to the *Financial News* says that on the German Stock Exchange a good deal of attention is being devoted to industrial ventures. A good deal of activity has been manifested in the shares of electrical enterprises, and the upward movement which has taken place is probably in part attributable to the intended conversion of the Grosse Berliner Pferdebahn into a company with electrical power. Arrangements have been made with the Berliner Electricitats Werke to supply the electricity, and an increase of capital may be looked for here. The Allgemeine Electricitats Gesellschaft, the parent company, is entitled, according to former stipulations, to subscribe for half of the new shares at par, and the old ones are now valued by the market at a premium of 28 per cent. It is expected that the Berlin Tramways Company will shortly increase its capital by the issue of two series of new shares of about 20,000,000 marks each. The existing shares are at a premium of 400 per cent.; but a further rise is anticipated, the most of the shares being in strong hands. A fair demand also exists for shares of the Bank of Electrical Enterprises, Zurich. A number of new electrical enterprises have made their appearance recently, and among these may be mentioned that launched under the auspices of the firm of Felix Singer & Co., and that which has commenced operations at Cologne in conjunction with the Helios Company.

Improvements in the Electro-Metallurgy of Zinc.—The great feature of this new process is the ammoniacal bath, an ingenious chemical application which permits the economic extraction of zinc from zinc ores, and of metallic zinc and metallic copper from zinc ores containing copper, together with the production of oxygen gas. The ores, which have been thoroughly oxidised by roasting, are ground and treated with a concentrated solution of either the normal carbonate, the sesquicarbonate, or the bicarbonate of ammonium, or a mixture of these; or a solution of ammonia gas in water may be employed, but in the latter case no oxygen is evolved in the later stages of the process. The bath is covered with a layer of paraffin or other mineral oil of high flashing point and low viscosity, to prevent loss of ammonia, and a mechanical stirrer is set in motion. When all the oxides have been dissolved, the clear liquor is drawn off into another tank, and again covered with a layer of oil. The solution is freed from any iron it may contain by treatment, at about 40° C., with a certain proportion of hydrated oxide of tin, and the clear liquid is again drawn off into another tank. If copper be present, it is recovered by immersing in the bath plates of zinc, or, preferably of zinc in contact with tin, and the copper deposited on the zinc strips easily, and is entirely free from oxides, owing to the layer of oil. The solution, free from copper, is electrolysed in a bath covered with a layer of paraffin, and provided with sheet zinc cathodes and tin or lead anodes. If a solution of the carbonates has been employed, the oxygen given off at the positive pole is collected and washed.

Hoepfner's Electrolytic Process for Producing Silver, &c., from the Ores.—This process enables the direct production of copper, silver, and other metals to be accomplished directly from the ores. It is minutely described in the *Engineering and Mining Journal*, 1896, Vol. 62, (22), 512. The powdered ores are first leached with a warm solution of cupric chloride, containing some chloride of sodium or calcium, by which the silvern copper, lead, bismuth, and some iron and arsenic are extracted. From the solution containing cuprous chloride the silver is precipitated by metallic copper, the chloride of lead deposited by cooling, and the antimony, bismuth, and arsenic precipitated by powdered limestone. Finally, the iron, when in excess in the solutions, is separated by the action of air, according to the following equation:—

$$2\ Cu_2\ Cl_2 + 2\ Fe\ Cl_2 + O_3 = 4\ Cu\ Cl_2 + Fe_2\ O_3.$$

The solution of cuprous chloride thus purified is then conveyed to the electrolytic baths, which contain cells with anodes of artificial carbon and cells with cathodes of sheet copper, separated from each other by diaphragms consisting of linen, cotton, or the like. This solution is divided into two separate currents, of which one brought into contact with the cathodes loses all or part of its copper contents, whilst the other, brought in contact with the anodes, is reconverted into a solution of cupric chloride. After leaving the bath the currents are reunited, thus forming a solution of cupric chloride similar to the original one for the treatment of the ore. If zinc or nickel be present in the ores, all or part of it will be extracted, and can be electrolytically deposited from the purified solution. In a series of baths first the copper, then the lead, nickel and zinc will be deposited. The cost of extracting the various metals is given, and owing to the better electrical conductivity of the chloride solutions as compared with the sulphate hitherto used, twice the amount of copper can be deposited in the same time with the same current. Analysis of the copper thus directly obtained from ores containing considerable impurities, show that it is practically pure. By means of the process described, neither gold nor the whole of the zinc is extracted. If these metals be present in remunerative quantity, the ores or the residue of the ores subjected to the preliminary extraction of copper and lead, are roasted in an ordinary furnace to convert the sulphides into oxides, and the gold is then extracted by chlorine. The oxide of zinc is converted into chloride by means of chloride of calcium or any other convenient means, and the metal electrolytically deposited with the simultaneous production of free chlorine.

The Electrolysis of Salts and Bases.—When alkali salts are electrolysed in the presence of ammonia, so that the cation sets free hydrogen, and the anion (by reacting on the ammonia) nitrogen, the amount of nitrogen liberated is relatively too small. S. M. Losanitsch and Z. Jovitschitsch have examined the causes of this irregularity, using graphite anodes and platinum cathodes. Electrolysis of Na Cl with $NH_4\ OH$, gave too little nitrogen by 10 per cent. After the electrolysis, hypochlorite was found to be present, and also chloride of nitrogen. Losanitsch and Jovitschitsch believe that the hypo-chlorite is formed directly, as when chlorine water reacts on ammonia. When the hypochlorite has attained a certain concentration, it forms with the ammonia chloride of nitrogen; this again reacts upon the ammonia, and nitrogen is set free. The amount of undecomposed hypochlorite depends upon the concentration and temperature, increasing as the temperature falls, and the solution becomes weaker in NH_3. At a certain concentration and temperature, the amount of nitrogen evolved should be strictly equivalent. (This was verified by experiment. Solution, Na Cl : NH_3 = 9 : 1; temperature, 100°.) When KBr, KI, and KF are electrolysed in the presence of ammonia, hypobromite, hypoiodite, and iodide of nitrogen are found to be formed. No hypofluorite or bromide or fluoride of nitrogen could be detected. Hence the non-equivalence in the electrolysis of KF must be due to the fluorine action upon the electrode. When KOH and K_2SO_4 are electrolysed, part of the oxygen developed is set free as such, and the rest goes to form nitrites and to set free nitrogen. Other examples of a similar action of nascent oxygen are given. The above is an abstract of a paper by S. M. Losanitsch and Z Jovitschitsch, in the *Berichte der Deutschen Chemischen Gesellschaft*, 29, pages 2,436—2,438.

Electricity in the Production of Uranium.—H. Moissan, whose researches in connection with the electrical furnaces are well known to our readers, has succeeded in obtaining uranium by heating in the electric furnace a mixture of the oxide with sugar carbon. The oxide was prepared by heating nitrate of uranium. In 12 minutes a button of uranium weighing 200 to 220 grammes was obtained. The proportion of carbon in the cast metal varied according as the oxide or the carbon predominated in the mixture. It was found that under the following conditions, if the heating were carefully carried out, the metal could be prepared containing little or no carbon. About 500 grammes of a mixture of 500 parts of oxide of uranium with 40 parts of sugar carbon was placed in a carbon crucible and heated in the electric furnace with a current of 800 amperes at 45 volts. A fused ingot, weighing 350 grammes, was obtained. If the mixture be heated too long, the metal carbonises very easily, and eventually a crystallised carbide, $C_3\ U_2$, is formed. To prevent the action of nitrogen, the experiments are best made in a carbon tube closed at one end. Moissan also obtained metallic uranium by electrolysis of the fused double chloride of uranium and sodium. The salt, which is kept fused by the calorific action of the current, was placed in a cylindrical porcelain jar, covered by a plate of glazed porcelain, through which passed the two pure carbon electrodes and a glass tube bent at right angles. Through this latter a current of perfectly dry hydrogen devoid of nitrogen, was led above the fused salt. After completely cooling, the contents of the jar were taken up by ice-cold water and then directly washed in alcohol, since uranium in a fine state of division decomposes water at the ordinary temperature. By using an iron electrode, alloys of uranium and iron can be obtained. These are white as silver, can be easily filed, and have a very fine grain. Uranium, when fairly pure, is absolutely white; when yellow, nitrogen is probably present. Uranium can be filed easily, and will not scratch glass. It carbonises slightly when heated in carbon dust, and can be tempered. When free from iron it is non-magnetic. Uranium is much more volatile than iron in the electric furnace, and can be distilled, small metallic spheres, free from carbon, being obtained on condensing the vapour.

Electricity in Gold Milling.—In the proceedings of the Engineers' Club at Philadelphia, *vide* Vol. 13 (3), p. 214—218, H. M. Chance classifies the methods by which it has been proposed to use electricity in the extraction of gold. These are as follows:—(1) *Electro-Magnetic*, in which a magnet is used to separate iron and other magnetic materials from particles of gold. Such methods have never been of practical importance. (2) *Electro-Solvent*, in which the ore, crushed or whole, is immersed in some solvent of gold (chlorine, potassium cyanide), through which an electric current passes. No process based on this idea seems to be actually at work. (3) *Electro-Amalgamating*, in which a current of electricity is passed from some part of the crushing apparatus through the water to the amalgamating plates or mercury pots, with the idea of aiding the amalgamation. This seems to be more or less effectual in keeping the amalgamating surfaces bright, and preventing sickening; in one instance where such a process was applied to tailings, a considerable saving of gold was effected. (4) *Electro-Precipitating*, in which the gold, having been got into solution by chemical means, is deposited electrolytically. In the Siemens-Halske process, largely used in South Africa, the anodes are cast-iron plates, and the cathodes sheet lead, arranged as baffle plates in a trough through which the solution slowly flows. When sufficiently coated the cathodes are melted, and the gold cupelled with 8,000 square feet of cathode surface, 100 tons of solution can be dealt with in 24 hours. (5) *Electro-Inductional*, in which high frequency alternating currents are employed, with the idea of causing electric attractions between the particles of gold in ores which contain the metal in grains. No application of this on the large scale appears to have yet been made. (6) *Electro-Smelting*. This does not appear to have been put in practice to any extent, no doubt because it is more expensive than the ordinary smelting processes. That more successful applications of electricity to gold extraction have not been made, is probably due to the fact that electricians who have worked in this field have not had a sufficiently intimate acquaintance with the conditions of gold-milling practice.

Note on the Theory of Lead Accumulators.—In a recent paper in the *Zeitschrift für Electro-Chemie*, W. Löb severely criticises the well-known theory of the lead secondary cell propounded by Prof. Elbs. In electrolysing a solution of lead diacetate under certain definite conditions, Elbs succeeded in observing the formation of lead tetra-acetate, the acid residue which was left after the deposition of lead uniting with the salt present:—

$$Pb(CH_3 . COO)_2 + 2(CH_3 . COO) = Pb(CH_3 . COO)_4.$$

The tetra-acetate thus produced is decomposed by water, forming lead peroxide and acetic acid:—

$$Pb(CH_3 . COO)_2 + 2H_2O = PbO_2 + 4\ Cb_3 . COOH.$$

Thus the tetra-acetate can only be obtained when no water is present; in aqueous solution, all that is observed is a separation of lead peroxide. This Elbs regards as a secondary process, whereas Liebenow and Löb regard it as a primary phenomenon. Elbs's theory requires that lead and lead peroxide should be produced in corresponding quantities in the cell. But this is not in accordance with experience; for if we electrolyse with a large anode, by far the greater part of the lead present appears as lead peroxide. The fact that tetra-acetate is formed in the absence of water, does not justify us in drawing conclusions as to the nature of the reactions which occur when water is present.

To Reduce the Coal Bill.—We understand that on Wednesday the Electricity Committee recommended the St. Pancras Vestry that a bonus of £20 be divided among the stokers at the Regent's Park electrical station, and also a bonus of £20 among the stokers at the King's Road Station for every tenth of a penny saved in the cost of the coal bill below a certain maximum limit.

The Gas Engine Industry in the United States.—It is a noticeable fact, says the *Scientific American*, that although the gas engine industry has been advancing with rapid strides in England and on the Continent, it has made comparatively slow progress in this country. This is said with the knowledge that gas engines as well-designed and as efficient as any in the world are built in the United States, and the statement is intended to apply chiefly to the development of the trade. Visitors to the recent gas exposition in New York must have noticed that although a few excellent types were shown, the gas engine, as such, was conspicuous by its absence. This may have been due, however, to the fact that the exposition was devoted chiefly to lighting and heating, and the various methods of gas production. How comes it that a people which is so quick to appreciate a useful device should have given comparatively little attention to the gas engine, and have left it to other nations to demonstrate its efficiency and introduce it on a large scale into their various industries? The causes are various. They are chiefly to be found in the cheapness of steam coal and the high cost of gas in the United States. No doubt the cost of gas illumination has something to do with the wonderful development of electric lighting in this country, and the same cause must have operated to develop the electric motor as against the gas engine. That the price of gas must have exerted a powerful influence on the gas engine industry is rendered probable by a comparison of the prices paid here and in England. The city of Manchester, which has about the same population as the city of Boston, sold its gas in 1893 at the rate of 60 cents per 1,000 feet; and the consumption was 3,636,000,000 feet, or more than the total amount furnished by the whole State of Massachusetts, where the gas costs on an average $1·50 per thousand feet. In Newcastle-on-Tyne the users pay only 40 cents a thousand feet, and when we bear in mind that makers are building engines which they will guarantee to use only 20 cubic feet per hour, the popularity of this form of engine in England is largely explained. It is reasonable to suppose that when this industry, which in respect of its proportions is yet in its infancy, has attained the importance which it has in Europe, it will tend to reduce the price of gas, especially such gas as is used for cooking and power purposes; and the gas companies themselves will undoubtedly benefit by the growth of the industry, the increased consumption more than compensating for the reduction in price.

Telegraphy without Wires.—The following letter from Dr. O. J. Lodge appeared in Tuesday's *Times*:—"It appears that many persons suppose that the method of signalling across space by means of Hertz waves received by a Branly tube of filings is a new discovery made by Signor Marconi, who has recently been engaged in improving some of the details. It is well known to physicists, and perhaps the public may be willing to share the information, that I myself showed what was essentially the same plan of signalling in 1894. My apparatus acted very vigorously across the college quadrangle, a distance of 60 yards, and I estimated that there would be some response up to a limit of half a mile. Some of the hearers of Mr. Preece's recent lecture at the Royal Institution seem to have understood his reference to these previous trials to signify that I had asserted or prophesied that more powerful apparatus would always be limited to some such distance; whereas my statement was a scientific one, concerning the small and early apparatus which, with the help of my assistant, Mr. E. E. Robinson, I had at the time devised and constructed. My apparatus was substantially the same as that now used by Signor Marconi—there was a row of sparking spheres; the sparks were taken under oil sometimes, as suggested by M. Sarasin; there were iron and brass filings in a high vacuum and likewise in hydrogen; there was also my own coherer with a single contact, which is more sensitive, but less manageable, than a filings tube; and the restoration to sensitiveness was effected by an electrically-worked hammer. Signor Marconi uses nickel and silver filings in a lower vacuum, and by employing greater power he has obtained signals over much greater distances; moreover, instructed primarily by Prof. Righi, and aided in his trials by the British Post Office, he has worked hard to develop the method into a commercial success. For all this full credit is due—I do not suppose that Signor Marconi himself claims any more—but much of the language indulged in during the past few months by writers of popular articles on the subject about 'Marconi waves,' 'important discoveries,' and 'brilliant novelties' has been more than usually absurd. The only 'important discovery' about the matter was made in 1888 by Hertz; and on that is based the emitter of the waves; the receiver depends on cohesion under electrical influence, which was noticed long ago by Lord Rayleigh, and has been re-observed in other forms by other experimenters, including the writer in 1890."

The Electrolytic Desilverisation of Argentiferous Lead.—At a meeting of the Paris Academy of Science, D. Tommasi describes a method of desilverisation by electrolysing lead which contains silver. The process is more fully described in the *Comptes Rendu*, but its essential details are as follows:—The argentiferous lead is cast into suitable anodes; the cathodes are discs of a metal which is not attacked by the bath. The latter may be copper, aluminium bronze, or even sheet-iron, but cast-iron would precipitate metallic lead from the bath. The electrolyte is a double acetate of lead and sodium, or of lead and potassium. Under the action of the current, the lead is removed from the anodes and deposited in the form of spongy crystals upon the cathode; while the silver contained in the anode, being insoluble in the bath, falls into a perforated receiver at the bottom. The silver is washed, dried, fused in a crucible with sodium nitrate and a little borax, and cast into ingots. The fusion with sodium nitrate converts any antimony and arsenic which may have been precipitated with the silver, into antimoniate and arsenate, whilst the silver remains in the metallic state. The lead is detached from the discs, washed and submitted to great pressure. It is then fused in a crucible with 2 or 3 per cent. of carbon, and cast into ingots.

NEW COMPANIES REGISTERED.

Edisonia, Limited (52,977).—Registered June 15th, with capital £40,000, in £5 shares (4,000 preference), to acquire the license granted to J. E. Hough by the Edison-Bell Phonograph Corporation, Limited, and to manufacture, sell, and deal in phonographs, graphophones, cylinders, Röntgen machines, and other instruments.

The subscribers (with one share each) are: J. F. Kelly, 26, Bonham Road, Brixton, accountant; M. S. Giles, 41, Mervan Road, Brixton, engineer; J. Tester, 83, St. Dunstan's Road, Hammersmith, manager; S. Herring, 87, Grove Green Road, Leytonstone, secretary; B. S. Fitch, 38, Blandford Square, W., electrician; F. G. Burton, 1, High Street, Aldgate, merchant; L. C. Bluff, 46, Loraine Road, Holloway, traveller. The number of directors is not to be less than three, nor more than seven. The subscribers are to appoint the first. Qualification, £1,000; remuneration, £500 per annum, divided. J. E. Hough is the managing director, with £500 per annum. Registered by E. Lloyd, 23, Wormwood Street, E.C.

London Provincial Electrical Company, Limited (53,003).—Registered June 17th with capital of £60,000 in £1 shares, to acquire and carry on the business of electrical engineers, contractors, and manufacturers carried on at Birmingham by W. R. Ridings, L. B. Codd, and T. Evans, as "Ridings, Codd & Co.," and to adopt an agreement with W. G. Richardson. The subscribers (with one share each) are:—C. M. Trevor, 48, Queen's Gardens, Hyde Park, W., solicitor; F. W. Loxton, 86, Herbert Road, Manor Park, E., clerk; B. C. Alexander, 12, Victoria Road, Gipsy Hill, clerk; E. J. Howell, 16, Mark Lane, E.C., merchant; C. H. De R. Hensley, 51, Earl's Court Square, S.W., gentleman; H. E. Hammerton, 1, St. Barnabas Villas, Guildford Road, S.W., clerk; T. W. White, 59, Approach Road, Victoria Park, E., clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £200; remuneration £100 each per annum (£150 for the chairman) and a share in the profits. Registered by Paddison & Co., Suffolk House, E.C.

Melton Mowbray Electric Light Company, Limited (53,018).—Registered June 18th, with capital £10,000, in £5 shares, to carry on the business of electricians, mechanical engineers, suppliers of electricity, and the general business of an electric light company. The subscribers (with one share each) are:—L. L. Powell, J.P., the Elms, Melton Mowbray; J. J. Fast, J.P., Melton Mowbray, builder; A. H. Mark, Melton Mowbray, solicitor; E. Seeves, Melton Mowbray, architect; J. T. Crosker, Melton Mowbray, cheese factor; W. J. New, Melton Mowbray, solicitor; S. C. Hobson, Melton Mowbray, director. Registered without articles of association by Hunnard & Co., 2, Tanfield Court, Temple.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

China and Japan Telephone Company, Limited (17,831).—This company's annual return was filed on June 11th, when 14,761 shares were taken up out of a capital or £20,000 in £1 shares, and all considered as fully paid.

Eastern Extension, Australasia and China Telegraph Company, Limited (7,224).—This company's annual return was filed on May 19th, when 250,000 shares were taken up out of a capital of three millions in £10 shares, and all paid for in full.

Western and Brazilian Telegraph Company, Limited (7,251).—This company's annual return was filed on June 4th. The capital is £1,500,000 in 66,871 shares of £15 each, and 66,258 shares of £7 10s. each; 64,257 of the former and all the latter have been taken up, the full amount called, and £1,460,790 paid. £565 has been paid on 75 forfeited shares.

Edison-Bell Phonograph Corporation, Limited (37,655).—This company's annual return was filed on April 5th, when the capital of £60,000 in £5 shares was fully taken up; 4,000 shares are considered as paid, and £40,000 has been called and paid on the others.

Corlett Electrical Engineering Company, Limited (36,200).—This company's annual return was filed on May 15th, when 620 shares were taken up out of a capital of £10,000 in £10 shares; 100 are considered as paid, and £5,200 has been called and paid on the others.

CITY NOTES.

The Electric and General Investment Company, Limited.

THE report of the directors to be submitted to the eighth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad Street, London, E.C. (Hall No. 43), on Friday, July 2nd, 1897, at 3 p.m., states that the profit and loss account shows a gross profit on the transactions of the year of £15,052 8s. 4d., and after deducting all standing charges, the interim dividend already paid on the ordinary shares, and a further provision for contingencies of £5,026 1s. 1d., there remains a net balance of £7,000 available for distribution. The directors now recommend that this sum be applied to the payment of a further dividend at the rate of 40 per cent. per annum for the past six months on the ordinary shares, making, with the interim dividend, a distribution of 25 per cent. for the year upon the capital paid up thereon. In accordance with the provisions of the company's articles of association, the holders of the founders' shares are entitled to a distribution of £30 per share. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making a total distribution of £50 on each founders' share. The reserve fund of £10,483 7s. 1d. has been invested, and the securities placed in the names of trustees on behalf of the ordinary shareholders.

The directors retiring this year are Mr. J. B. Braithwaite, jun., and Mr. Emile Garcke, who being duly eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election.

It is proposed to make the dividends payable on July 3rd, 1897.

The British Insulated Wire Company, Limited.

IN another part of this issue will be found a copy of the prospectus of this company, which has been formed for the purpose of taking over as a going concern the business, property and assets of the old company of the same name, which has since 1890 carried on at Prescot the business of manufacturers of electric lighting, telegraph, telephone, and other cables, and electrical appliances.

The objects of the new company are to bring additional working capital into the business, to enable the increasing volume of business to be adequately dealt with. The orders taken over from the old company exceed £200,000 in value, and other contracts have been subsequently booked.

The total assets (exclusive of good will) are stated at £223,149 odd. The liabilities taken over are the debenture issue of the old company of £47,400, and the interest and dividends due thereupon to April 27th, 1897 (estimated £9,000), will be met by the new company.

The ordinary business debits taken over are estimated at about £54,000. The net profit for the year 1896 was £36,095, and for the first four months of this year it amounted to £16,890 (an increase at the rate of 45 per cent. per annum over 1896). The authorised share capital is 40,000 6 per cent. £5 cumulative preference shares, and 40,000 £5 ordinary. The present issue comprises the whole of the ordinary and 20,000 of the preference. Of these, 14,470 preference shares and 10,375 ordinary shares are offered for subscription, leaving £100,000 preference capital for future issue if required; the balance of the present issue is taken by the shareholders in the vendor company in full payment of purchase money. The directors and management of the new company is the same as in the old company. The list will open on Monday, June 28th, and close on or before Thursday, July 1st.

Edison and Swan United Electric Light Company, Limited.—This company is offering for subscription at par an issue of £90,000 4 per cent. debenture stock, which, with the £110,000 already issued, will form part of a total amount of £350,000 authorised, which stock is to be placed from time to time for the purpose of redeeming the £100,000 4½ per cent. stock issued in 1894, and also of providing for the rapid growth of the business. The stock now offered will be subject to redemption at £110 per cent., and will be secured on the redemption of the existing stock, which will be completed on 30th inst., as a first charge on the uncalled capital and other assets, totalling £417,346. The profits for the two years ending June 30th, 1896, were £25,876 and £27,526 respectively, and the company's capital paid up on the "A" shares is £383,478. The 30th inst. is the latest date for receiving applications. The trustees are Sir John Lubbock and Mr. James Staats Forbes.

Salt Lake and Ogden Gas and Electric Amalgamation.—The Gas, Water, and General Investment Trust, Limited, intimates that a provisional arrangement has been entered into for the consolidation of the Salt Lake and Ogden Gas and Electric Light Company, of Utah, with certain other electric light and power companies in the neighbourhood of Salt Lake City, and requests the holders of the issue of $1,500,000 6 per cent. first mortgage gold bonds of the above named company to lodge their bonds, with the July 1st, 1897, coupon attached, at the office of the trust, 251, Winchester House, E.C., in order to enable such amalgamation to be carried into effect.

Anglo-Portuguese Telephone Company, Limited.—Coupons No. 19 of the first mortgage and No. 14 of the second mortgage debentures will be paid, less income-tax, by Parr's Bank, on and after 1st prox.

Siemens & Halske.—It is announced that the firm of Siemens & Halske was, on 18th inst., formed into a joint-stock company with a share capital of 35,000,000 marks.

National Telephone Company, Limited.—The directors have allotted the 130,766 third preference shares recently offered for subscription by tender at an average price of £5 16s. 6d. per share.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 20th, 1897, were £1,093; week ending June 21st, 1896, £836; increase, £257; total receipts for half-year, 1897, £25,308; corresponding period, 1896, £23 17s. 8d.; increase, £2,130.

The Liverpool Overhead Railway Company. The receipts for the week ending June 20th, 1897, amounted to £1,389; corresponding week last year, £1,221; increase, £168.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 18th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,019.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, June 16th.	Closing Quotation, June 23rd.	Business done during week ended June 23rd, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	52 — 55	52 — 55	52½	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	98 — 99	98 — 99	99	98
3,038,920	Do. do. Defd	Stock	...	...	...	9½ — 10	9½ — 10	9½	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	15⅝	15 3/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	114 —118	114 —118	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	173 —177	173 —177	...	...
400,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —105	104 —105	105	104⅝
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16 — 3/32 xd	1/16 — 3/32	1/8	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ — 10½	9½ — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108%	105 —108 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9 — 9½	9½ — 9½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼%	6¼%	...	17 — 17⅞	17 — 17½	17⅝	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅝	18½
89,900	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	128 —131	128 —131	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7¾	17⅞ — 18¼	17⅞ — 18¼	18⅛	17⅞
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	}100	5 %	5 %	5%	101 —105	101 —105	104	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	129 —132	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5 %	5%	101 —105	101 —105	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	}100	4 %	4 %	4%	105 —108	105 —108	106	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	108½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11¼ — 11⅝	11¼ — 11⅝	11⅝	11⅝
180,042	Do. do. 5 % Pref.	10	6 %	6 %	6%	17 — 17½	17 — 17½	17⅝	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅛%	10 %	10⅛	25 — 26	25 — 26	25⅝	...
160,000	Do. do. do. 5 % Debs.	100	5 %	5 %	5⅛	104 —107	104 —107	106½	104
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10⅛	54 — 57	54 — 57	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅝ — 6⅞	6⅝ — 6⅞	6⅞	6 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 3/16	6 1/16
1,323,471	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —109	105 —109	108	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	}100	4 %	4 %	4 %	107 —110	107 — 110	107½	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	7⅝	...
3,381	Submarine Cables Trust	Cert	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½ — 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	103¼	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 — 104	101 —104	...	...
64,256	Western and Brazilian Teleg., Ltd.	5	3 %	3 %	2 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	...	...
33,129	Do. do. do. Def. Ord ...	7½	1 %	1 %	...	1½ — 2¼	1½ — 2¼	...	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	99 —102	99 —102	101	99¼
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	1 %	⅞ — 1⅛	⅞ — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½ — 11	10½ — 11	1	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10	9 — 10	10½	...
80,000£	Do. do 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	107 —110	107 —110	8½	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 — 108	104 —108	...	...
162,200	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	13 — 14	13 — 14	13 1/16	13¼
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ — 6⅝	6¼ — 6⅝	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9½ —10	9⅝ — 10¼	10	9⅞
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ — 24½	23½ — 24½	23⅞	23⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17½	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	131 —136	133½	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12⅜ — 13¼	12⅜ — 13¼	13 3/16	12 13/16
10,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	15 — 15½	15 — 15½	15	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	.	14⅜ — 15¼	14⅜ — 15¼	15½	14¾
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8¼ — 9	8¼ — 9	8 13/16	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½ — 17½	16½ — 17½	16⅝	...
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	13½ — 14½	13½ — 14½	...	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½ — 16½	15½ — 16½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅝	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 69,000 ...	5	5 %	7 %	9 %	14½ — 15½	15 — 16	15 1/16	15⅜

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES - *Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, June 16th.	Closing Quotation June 23rd.	Business done during week ended June 23rd, 1897. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	£	2½%	...	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	...	...	1½ — 1⅝	1½ — 1⅝	...	...
125,000/	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	...	...	105 —109	105 —109	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10¼	...
143,105	Do. do. do. £6 paid	10	...	...	...	5⅞ — 6¼	5⅞ — 6¼	...	...
51,951	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
54,521	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	4⅜	...
630,000/	City and South London Railway	Stock	1⅛%	1 5/16%	1 5/16%	58 — 60	58 — 60	60	59½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅞ — 2¼	1⅞ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2 — 2⅛	2⅛ — 2⅜	2⅛	2⅜
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3½ — 4½	3½ — 4½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1⅝ — 1⅞	1⅝ — 1⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜ — 3½	2⅜ — 3½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾ — 1	⅞ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ — ½	⅝ — ⅝	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ — 19½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	08 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1¼%	2⅞%	2⅞%	12⅜ — 12⅝	12⅜ — 12⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	35 — 38	36 — 39	38¼	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000/	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	11	10⅞

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 5% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.
British Electric Traction, 12—12½.
Electric Construction Corporation, 6 % Debentures, 105—108.
House-to-House Company, 7 % Preference, of £5, 10—10½.
Do. do. 4½% Debentures of £100, 109—112.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 12⅞—13¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8¼. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1⅞—2⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8⅜. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

ON DYNAMOS. By W. M. MORDEY, Member. (Paper read May 20th, 1897.)

(*Concluded from page* 844.)

BRUSHES AND COLLECTION.

34. The importance of good collection makes it worth while to carefully study, not only the main conditions, but any minor effects that bear on it. Dynamos may be designed so liberally that they are almost incapable of sparking under any circumstances. But this is expensive, and we should try to develop less costly methods, and, if possible, find how to check tendencies to sparking. Prevention is not always better than cure. Many inexpensive dynamos, if cured of sparking, would be quite good and useful machines.

35. There are few matters of which our knowledge is less definite than the exact actions in the region of the neutral line, or even the precise causes of the movement of that line. This line of best collection is usually assumed to be definitely determined by conditions depending on the armature turns and current, the strength of the field, and so forth—that in a given machine, with a given load, the angle of lead is quite definite, and only to be altered by structural modifications of the machine, such as increase of gap or change of polar surface. But, as a matter of fact, it is quite possible to shift the collecting line without any structural alterations—not merely to collect further back, but to get the *best* collection further back, and good collection no longer possible at the forward position, which previously was the best one.

36. Among the numerous and complicated actions that take place under the brush, there is one that has an important influence on the angle of lead—that is, the amount of current flowing in the short circuit. As the coils go successively under the brush and are short circuited, the pre-existing direction of current is continued, then it falls to zero, and then, as the coil passes out from under the brush, it rises again in the opposite direction. It will be clear from fig. 11 that this short circuit current may quite perceptibly increase the armature reaction by adding to the demagnetising effect in the "magnetising space." The amount of this current may vary, in different dynamos, from very small values up to something considerably more than the working current; that is to say, when the coil goes under the brush the current may either fall quickly or slowly to zero, or it may rise to several times the working current before falling to zero. The large circles in fig. 11 indicate the large short-circuit current, and show clearly how it may add to the demagnetising effect. Experiment has shown that by checking this current it is possible to considerably reduce the lead angle.*

37. Even in a dynamo which works sparklessly and well, the short circuit-current may be serious in amount. It is harmful in many ways. It causes waste of power both in the short-circuit itself, and

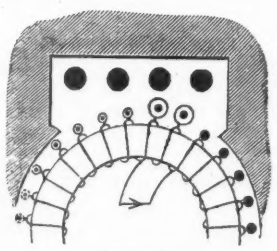


FIG. 11.

in the field winding, which must be increased to compensate for it. It reduces the output by lowering the sparking limit, by increasing the lead, by increasing the drop of volts,—by requiring larger brushes and commutators than would otherwise be used.

This short-circuit current may be checked by an opposing E.M.F. or by a resistance; the former requires structural alterations.

Resistance in Commutator Leads.

38. The obvious way to check such short-circuit currents is by the insertion of resistance in the portion of the circuit under commutation, as, for example, between the commutator and the collector. This is easy; and as the resistance is only in circuit as the coil passes the brush, and at no other time, an amount may be added large in proportion to the resistance of the coil short-circuited, but small as compared with the whole armature. But this plan, although it pos-

* In explaining this effect, a preference may be felt for regarding the gain as due to the smaller reversing field required (and therefore smaller lead), resulting from the more rapid reduction of the existing current; this comes to pretty much the same thing.

sibly has some effect on armature reaction, has no marked effect on sparking, for a very simple reason. To break a circuit without sparking, a resistance should be gradually introduced, and the circuit resistance is a maximum, and the current a minimum. Unfortunately this is not what happens in the case under consideration. The resistance is introduced and removed suddenly.

Experiment has confirmed this explanation. Resistance was added to the commutator connections of an armature, without any noticeable effect on the sparking. The amount was varied from something quite small to sufficient to increase the C R drop about 20 per cent.

Resistance in Brushes.

39. By a simple expedient the brushes themselves may easily be made to do what is wanted. An ordinary brush connects the adjacent sections by a path of very low resistance, allowing currents to circulate freely, checked by little more than the "contact resistance."

The study of reactions leads naturally to the perception of the qualities a brush should possess. It should have a low resistance, so that it may easily carry large currents, and it should have a high resistance, to prevent the circulation of large currents. Fortunately, this combination of opposite qualities is attainable by lamination across the path of the circulating currents. If a brush is slit or divided by insulating divisions (as in fig. 12), although it is just as effective as before for the main current, it opposes a much longer path than usual to a short-circuit current, which, in consequence, is much reduced.

40. And the graduation of the resistance so that it is removed gradually from the circuit is not difficult. A little thought will make it clear that, as sparking does not occur when a contact is made, but does occur when it is broken, we should encourage the current to enter the brush at the back, where the brush is making contact with the sectors as they successively pass under it; but we should discourage it from entering by the front, where the brush is breaking contact with the sectors as they successively pass away from it.

Such a distribution of current is facilitated by making a good contact at the side (? back side) of the brush, for which the current should have a preference, and a bad contact, or none at all, at the front side, where it is desired that only a small part of the current should enter. Fig. 12 shows this arrangement.

41. Brushes of this sort are easily made—for example, by placing together a number of thin plates or layers of carbon, or metal gauze or foil, with an insulator between the layers except near the end where they are brought into contact. With carbon plates a good plan

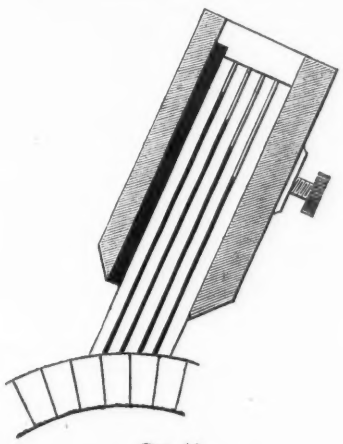


Fig. 12.

is to stick the plates together with an insulating cement except at one end, where tinfoil is put between them to ensure contact: they then form solid blocks like ordinary carbon brushes. Such brushes applied in a particular case gave a better collection, and only half the lead of ordinary copper gauze brushes; they were distinctly better than ordinary undivided carbon brushes.

42. Carbon brushes were originally proposed by Forbes.* Their good effect was at one time attributed to small friction against the commutator, and to some peculiar property by virtue of which the current passed to them more easily than to better conductors. Their success probably is owing simply to their high resistance, by which they are enabled to check reactions after the manner described.

One objection to carbon brushes is that on account of their high resistance, they require to be of larger section than other brushes; a density of 75 to 100 amperes per square inch being as high as they should be worked. If this density is exceeded they heat very much at the contact surface. Possibly they may be made to carry larger working currents when made so that the circulation of current through them is reduced. What the actual current density is at the contact face in any given case cannot easily be determined, as the circular effect so disturbs the distribution of the current at the face, by increasing it at one part and opposing it at another. The action of heat in changing the conditions, by varying the resistance, may also be worth a passing notice.

Drag on Buried Conductors.

43. Whether any mechanical pull is exerted directly on or by the conductors of armatures having sunk windings has been repeatedly discussed. It has, of course, been freely acknowledged that, in slotted armatures, the support given to the conductors by the teeth makes such armatures mechanically superior to those having smooth cores. But many able persons hold that the advantage goes no further—that the teeth act only as so many "driving horns," the torque coming on the conductors, which are actually driven by the teeth through the insulation. If this is the case, the conductors ought to be as securely fixed in the slots as possible, in order that the racking and hammering of the insulating material may not affect the life of the windings.

44. There is considerable importance in this matter, both theoretical and practical. The practical considerations are of the greatest possible importance, for on the answer to this question many vital things depend affecting the engineering aspects of electrical applications. Constructors of electrical machinery have laboured (or have often believed they laboured) under a very serious disability—one which often seemed to present an effectual bar to the thoroughly satisfactory solution of many electrical engineering problems. This disadvantage has been the use of very unmechanical materials for mechanical purposes. It is probable that every electrical engineer has respectfully watched a locomotive take a heavy train up an incline, or the passing of an express train at full speed, and has thought of what it would involve if this work had to be done by the medium of a pull exerted on cotton-covered copper conductors tied by piano wire to the surface of a smooth drum covered with shellaced paper and mica. The unmechanical character of insulators has always seemed to stand in the way.

45. But if there is no drag on a buried conductor it changes all this. We need then no longer envy the mechanical engineer, for we, too, can put metal to metal and make sound mechanical joints, and take our strains on the iron and steel parts of the machine instead of on flimsy copper and flimsier insulation materials. The windings, then, present no mechanical problems, and the unmechanical character of paper and cotton ceases to trouble us.

46 It may be thought that this point has long been settled, but that there is still much uncertainty about it is evident from quite recent utterances. This arises, no doubt, from the absence of experimental proofs—definite trials do not seem to have been made. An account of some trials is therefore given here:—

An inductor alternator was used having a stationary slotted armature, the polar projection of the rotor being one of polarity only. The arrangement is shown diagrammatically by fig. 13. One of the armature coils was removed, and in the empty slot was placed a con-

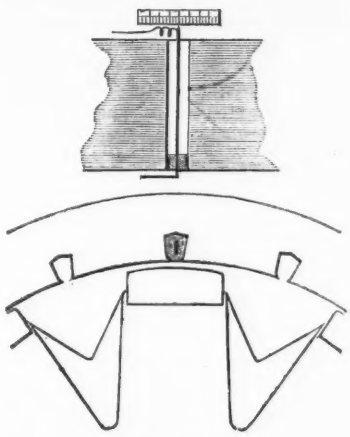


Fig. 13.

ductor consisting of a copper strip 1 inch × 0·1 inch, rigidly supported at one end, and free at the other. A connection was made to the free end by a flexible conductor, and a pointer was attached moving over a fixed scale to show the deflection of the conductor. The strip was joined in series with four of the armature coils, a Siemens dynamometer, and a non-inductive external circuit.

47. The following experiments were made:—

(i.) The machine was run at 25 ~ without any load except on the four coils and the strip (the whole armature contained 20 coils). The position of the pointer was noted on the scale. The circuit was then closed, and the current adjusted to 200 amperes. This caused a very perceptible vibration of the strip, the pointer showing a mean deflection of about 0·09 inch.

The machine was stopped, and the conductor loaded by a weight applied in the middle of the free active portion (which was 10 inches long), when it was found that a deflection of 0·09 inch was produced by a weight of ½ lb.

The calculation given below shows that if the full drag came on the conductor it would correspond to about 4¾ lbs., so that only about one-tenth of the full drag was borne by the conductor in this experiment.

(ii.) With the machine standing and a pole-piece opposite the slot, as in fig. 13, and the field excited as before, a direct current of 200 amperes was passed through the conductor: it was found that the steady deflection was rather more than before, viz., 0·12 inch.

From the data given by the tests of this alternator, 10 inches of active conductor (the length used in the experiment) would give 1·38 volts at the periodicity used, viz., 25 ~.

* British patent, No. 1,288, 1885.

Assuming no phase displacement,
200 amperes × 1·38 volts = 276 watts = 12,170 foot-lbs. per minute.
Surface speed at gap, 2,590 feet per minute.
Hence, if the full drag came on the conductor,

$$\text{Drag} = \frac{12{,}170}{2{,}590} = 4{\cdot}7 \text{ lbs.}$$

The comparison as to the effect of the drag and the weight is based on the assumption that the conductor was rigid and straight, instead of being slightly curved, as it would actually be; but the error produced by this assumption is unimportant.

It may be explained that in actual work the winding is such that each conductor carries about 80 amperes, and the ampere-turns in each slot are about 12 times those produced by the single conductor* with the current used in the tests.

These experiments appear entirely to support the view that the drag on the armature is borne by the teeth and not by the conductors in slotted armatures.

It is a little paradoxical that when teeth are not used the conductors need support, but have none; when teeth are provided the conductors do not need their support, as there is then nothing to drive.

ARMATURE EXCITATION.

48. With leading brushes the armature current opposes the field current. But with no load, leading brushes assist the field current under suitable conditions. That is to say, the effect with leading brushes is at no load the reverse of what it is at full load.

Consider a dynamo running without load. If the brushes are given a slight lead, as in fig. 14A, a current flows through the short-circuited coils in such a direction as to assist the field. Further, if a brush is made to span a number of sectors, as in fig. 14B, this assisting short-circuit current may be made to flow not only through the

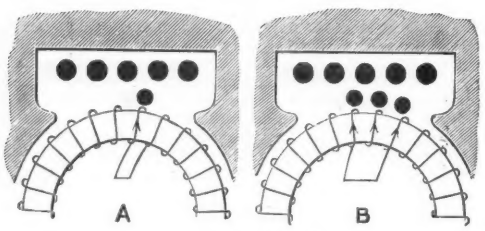


FIG. 14.

coils in advance of the neutral line, but through some of the coils behind the neutral line. To get this latter result it is only necessary that the short circuit should include a greater portion of the winding in front of the neutral line than behind it; then the E.M.F. of the forward coils will overcome that of the backward coils, and a current will be forced through the latter, contrary to their E.M.F. It will also be obvious that if the coils behind the neutral line are short-circuited by a brush, a demagnetising current will flow, which in a similar way may be made to extend to the front of the neutral line. The increase of excitation obtainable in this way is considerable. It was found quite easy to raise the volts of an ordinary dynamo 20 or 25 per cent. A much greater increase could be obtained momentarily, but excessive sparking made it undesirable to continue the experiment.

49. This effect is exactly the reverse of the short-circuit effect under the brushes referred to in the section of this paper headed "Brushes and Collection." But the two effects are not contradictory. In one case it is the working current in the armature behind the brush, and the continuance of the same direction of current under the brush, that opposes the field winding. The direction of current in front of the brush is always assisting; it is in this latter direction that the short-circuit current is set up under the conditions named, and the result is, naturally, to strengthen the field.

50. A rather interesting difference between the conditions of the magnetic circuit on the two sides of a dynamo may be referred to here. It was found, by experiment with a single-magnet Gramme dynamo, that, although the increase of volts was considerable when a wide brush was placed on the upper side, no further increase occurred when a similar brush was put on the lower side. Fig. 15 shows a single and a double horse-shoe form of magnet. In the former, the armature current in the magnetising space on the upper side is acting on a magnetic circuit, shown by the line L, which passes mostly through iron. On the lower side, however, the line L′ passes mainly through air, and consequently the effect of the current is not so great. This difference will, of course, be most marked in small air space dynamos.

In a double horse-shoe magnet, as shown dotted, the conditions on the two sides are similar.

Effects of this kind are best studied with a Gramme armature, as the short circuit caused by the brush is confined to the coils on a definite portion of the ring. In a drum, the short-circuited coils pass round the armature, and consequently the separate effects in the two magnetising spaces cannot be so well observed.

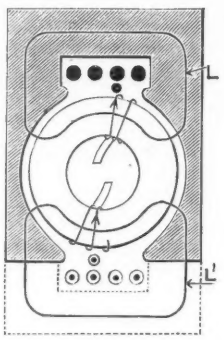


FIG. 15.

This subject is referred to only as illustrating armature reaction, and not for any immediate purpose of practical utility. It may, however, suggest a useful result to some ingenious person.

INTERNAL FIELDS.

51. The consideration of armature windings which reduce the amount of field winding required, and a recognition of the proper function of the field magnet, lead naturally to a revived interest in internal field magnets such as were introduced and advocated long ago by Profs. Ayrton and Perry.* There is now much to be said in favour of such arrangements. In those machines the armature and commutator were fixed, while the brushes and the internal shuttle-shaped magnet revolved. One only shrinks from recommending a return to such constructions because we have become accustomed to stationary brushes capable of adjustment while in use. But it would be unwise to sacrifice too much to retain this convenience. Our dislike to revolving brushes is to a great extent a legacy from the sparking age. If machines can be made to work sparklessly with brushes in a fixed position relatively to the field, then the main objection to revolving the magnet and the brushes is removed. The objection, even now, has not much force, as is evident from the common practice, as in tramcars, of running motors where they cannot, or do not, get any attention whatever when running.

52. Internal field magnets have been largely used on the Continent, the field magnets being fixed. Siemens and Halske and others have made very fine machines of this kind. Usually the outside of the armature is made to serve as commutator, but sometimes a commutator of ordinary form is used. As a type it is at present more especially suited to large sizes, because of the difficulty with small sizes of getting sufficient internal space for the magnet; but this difficulty disappears to some extent if we can reduce the amount of field winding and the cross section of the field core.

If this paper has seemed needlessly long, indulgence is asked on the ground that the object has been to make the explanations clear, not to experts only, but to all who take an interest in, and have a general knowledge of, the subject.

My thanks are due, amongst others, to Mr. L. Wilson and to Dr. Fleischmann, and in particular to Mr. A. G. Hansard, whose very able and willing assistance has been of great service to me in the preparation of this paper.

DISCUSSION.

Prof. S. P. THOMPSON congratulated Mr. Mordey on the excellent example he had set in reading his paper before the Institution of Electrical Engineers instead of presenting it to some alien institution. Four or five years ago he and Mr. Mordey had discussed a system of "cross-compounded," which, however, they had abandoned on finding that they had been anticipated by Prof. Ryan. It had occurred to him that the cross-compound winding might be used to fix their brushes once for all, altering the compensation electrically if required, instead of altering the lead of the brushes as the load varied. He admired the extremely simple device by which Mr. Mordey had dispensed with the necessity of giving lead to the brushes. He had, many years ago, pointed out that there was very little strain on sunk conductors, and had been disbelieved; he was very glad, therefore, to have his opinion confirmed by Mr. Mordey's experimental investigation.

* On this subject the following interesting observations by Mr. Swinburne appeared in *Industries and Iron* of February 2nd, 1894:—"Some electricians have difficulty in realising that in dynamos with notched armatures there is little or no force on the coils. They argue that as the conductors produce their full electrical pressure they must be cutting the field, and as they move uniformly and cut the field uniformly, they must be in a strong field, and must therefore have the same force acting on them as if they were on the outside of the armature. There is a fallacy here, however. The pressure depends on the rate of cutting lines, and the lines may be moving very rapidly in the opposite direction while they cut the wire, so that the actual field in which the wire finds itself may be very weak indeed. Imagine a notched armature and field. The lines will crowd into the teeth, and avoid the notches. Take any one line: as the armature moves, it cannot be imagined as being dragged round with it; it must, therefore, cross the notch to the next tooth. It will do this very quickly. To get an idea of what would be necessary to imagine the lines of induction, we can think of the appearance of iron railings seen through a carriage window with a knot or lump on the glass. There are practically no railings seen through the knot, and they are crowded on each side of it, and as the carriage moves they jump across the knot. The same number per second passes the knot as any other part of the window, but they are always less dense in the knot. The lines in a hole or notch-wound machine must be mentally pictured in this way."

* *Journal*, xii., p. 335, May 10th, 1883.

Mr. George Adams considered that the reason why toothed armatures were so little used in London was because of the difficulty of getting good steel castings. He thought there would be little improvement in the design of dynamos and motors so long as they were restricted to the use of steel.

Mr. W. B. Sayers said he had studied Mr. Mordey's arrangement, and was quite unable to see that any advantage could be got by adopting it. Mr. Mordey neutralised the "back turns" at the expense of the commutating power. The effect was the same as with Swinburne's chord winding, but with large machines, considerable commutating power was necessary, and this could only be got by the sacrifices condemned by Mr. Mordey. Mr. Mordey's plan of dividing the coil into two parts, to obtain sparkless commutation between the two poles was all right as long as there was no current in the armature. But when they got a load on, the "trailing" pole was strengthened, and the "leading" pole was weakened. He considered, as a result of careful study, that it was absolutely impossible to get commutating power from the "trailing" pole with a continuous winding, unless part of the coil were wound in an opposite direction. If this was done the E. M. F. would disappear or be fatally reduced. In the drum winding described by Mr. Mordey, in which the winding was so arranged that there was a direct magnetising effect due to the armature, this result was only obtained with considerable sacrifice of commutating power; the E. M. F. generated in the one bar which was running into the field under the "leading" pole has to reverse the current against the E.M.F. generated in the other three bars which are leaving the "trailing" pole tips, and the self induction of the whole of the four bars which constituted the coil. From his experience that would not work. In his (Mr. Sayer's) arrangement the commutating power was obtained from the trailing horn and increased with the load; in Mr. Mordey's the reverse was the case. He had found it impracticable to work with short air gaps; 1 mm. was the shortest he had ever used. Slight deviations from symmetery brought great strains on the bearings.

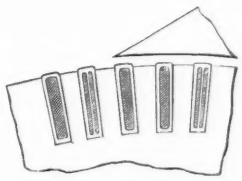


Fig. 1.

He found also that the width of the air gap must have a definite relation to the width of the top of the slot. If the openings at the top of the slots were too wide, eddy currents were generated. If, therefore, they wished to use very narrow air gaps, it was necessary either to laminate the field or to make the iron almost continuous round the armature conductor; in the latter case very nice adjustment of the brushes was necessary. He had discovered that the closing of the top of the slot increased the

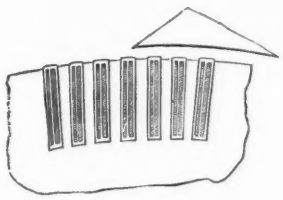


Fig. 2.

self-induction; for this reason he had to make his slots as nearly as possible parallel. To avoid making the air gap too great, he put the commutating bars into slots by themselves. (Drawings of various forms of slots suitable for different conditions were shown by Mr. Sayers. In figs. 1 and 2 (Sayers) the slots are parallel, and can therefore be planed out. In order to avoid making them too wide and so requiring a greater air gap, the commutating coils are put into separate slots. The two bars in separate slots are main coils; the two thinner ones together are bars forming commutating coils. Fig. 3 represents a 270 kilowatt machine, in which the air gap is ·375 inch. Fig. 4 refers to a machine having an air gap of 1 mm. The machine is a motor generator and has a comparatively weak field.) Mr. Mordey made no reference to the self-induction of the section which was being reversed under the brush. This back E.M.F. of self-induction was nearly proportional to the square of the number of bars simultaneously commutated in the same slot. It was desirable, in order to reduce self-induction, to distribute the bars forming a section of the armature over a number of slots and thereby increase the air path round the coils. He agreed with Mordey in his preference for the toothed armature. The reason why the strain on buried conductors was so small was because the lines of force were cut by the conductors at, say, 10 times the speed of the armature, as the lines moved rapidly from one tooth to the other. He wished to point out that Mr. Mordey's copper brushes separated by carbon slips did not really interpose resistance as was supposed, since each copper brush short circuited two sections as soon as it passed over the mica.

Mr. W. B. Esson pointed out that in 1885 he (Mr. Esson) had written some articles in the Electrical Review dealing very fully with the advantages and disadvantages of toothed armatures. He had then pointed out one objection, which Mr. Mordey had omitted to mention, namely, the heating effect of the teeth on the polar surface, when the air gap was small. He considered that the principal reason why the toothed

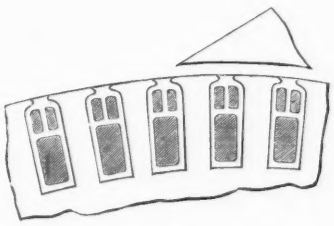


Fig. 3.

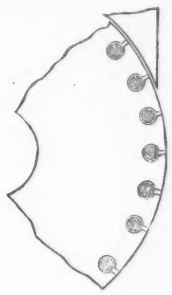


Fig. 4.

armature had not been generally adopted was on account of its greater expense. In two papers, read by Mr. Swinburne and himself in 1890, most of the points in Mr. Mordey's paper had been discussed. Mr. Swinburne had discussed air gaps, chord winding, sparking, &c., and he himself had discussed the symmetry of the field, and also the effect of the current in the short circuited coils on the field, whether the machine was loaded or unloaded, and whether the brushes had lead or trail. Mr. Mordey, he thought, lent strong support to the physiological doctrine that the particles of the human body were completely changed in 7 years, when his views in 1890 were compared with his views in 1897, for it was difficult to believe that he was now the same man. He remembered that Mr. Mordey had objected to the small air gap, and all the devices for the prevention of sparking proposed by Mr. Swinburne; he had objected to chord winding, and had condemned Profs. Ayrton and Perry for advocating this arrangement in dynamo and motor design. He considered that no blame attached to Mordey for altering his opinions, but he wondered where Mordey would be 7 years hence. He considered that the most original part of Mr. Mordey's paper was the part on the drag on buried conductors.

Mr. J. S. Raworth argued from the present practice of the Gramme Company at Brussels that Mr. Mordey's paper was certainly not ancient history, as Mr. Esson appeared to consider. He considered, in opposition to Mr. Sayers, that Mr. Mordey's design was applicable to small machines as well as to large. Mr. Sayers said that commutation was more difficult with multiple conductors than with single bars, but he had himself seen a 15-kilowatt machine in which the commutation was perfect. The Brush Company were so well satisfied with Mr. Mordey's results that they had taken a license under Mr. Mordey's patent.

Mr. E. K. Scott said that Mordey seemed to think that nothing had been done with internal field machines in this country; but they had been recommended some time ago by Prof Ayrton and a number had been built and the result of tests had been a considerable saving in cost. He considered that laminated field poles would give all that was effected by juggling with the armature coils. He had constructed a cheap brush from lamp carbons which was practically the same as Mr. Mordey's. The top ends of the carbons were cast in stereo metal.

Mr. H. A. Mavor said that Schuckert & Co., and other German makers had attained the same object as represented by Mr. Mordey in fig. 4, by approaching the pole pieces to one another. He believed that both these plans would work equally well. The real objection to short air gaps was the strains brought on the bearings by want of symmetry. Mr. Mordey's plan would be inapplicable to machines in which there was only one external conductor on a ring, or two on a drum armature.

Mr. R. E. Crompton said that about a year ago a Mr. Brown in his firm had commenced experiments on the same lines as Mr. Mordey. They found that the results anticipated by Mr. Mordey had not been realised with large machines. The conditions were so different with different sized machines, that he did not think Mr. Mordey was to bring about so great a revolution in dynamo building as he seemed to think. He had worked at the problem of revolving the magnets and keeping the armature stationary, but the difficulty of adjusting the revolving brushes when the current was on, had seemed to him insurmountable.

Mr. C. C. Hawkins thought that the true explanation of good results obtained with Mr. Mordey's machine had not yet been discovered. He could not *prima facie* see how, by any possibility, Mr. Mordey's winding could be applied to stop the sparking of toothed armatures.

Mr. C. H. Gadsby considered that the simplicity and cheapness of the ordinary winding would be lost in carrying out Mr. Mordey's system. It had occurred to him that this difficulty might be got over by slanting the grooves in the armature core.

Mr. W. M. Mordey, in reply, noted that Mr. Sayers and Mr. Mavor,

who had worked on the same lines for some years, differed as to the practicability of his plan. Mr. Sayers said that his arrangement would not work under certain circumstances except a lead was given to the brushes. He had never said it was not necessary to give a lead to the brushes, but he considered that he had greatly reduced the amount of the lead necessary. Mr. Esson seemed to think that most of the points in his (Mr. Mordey's) paper had been anticipated by Mr. Swinburne, but this was not the opinion of Mr. Swinburne himself from whom he had had a very appreciative letter. Mr. Esson had failed to construct good toothed armatures; he must now stand aside and let others try. Mr. Esson had reminded him that in 1886 he had objected to small air gaps; well, he still objected to small air gaps as they were made in 1886. In reply to Mr. Scott, he said there were no soldered joints in his winding. Mr. Crompton must have misunderstood him, if he thought he predicted a great revolution in dynamo building. As to Mr. Gadsby's suggestion about diagonal winding, he had been shown by Mr. Sayers, some years ago, a diagonal arrangement, but it had been tried and thrown aside, for what reason he did not know.

THE PRESIDENT regretted that Mr. Mordey's paper had not been read earlier in the session, so that a longer time might have been devoted to its discussion, but for this Mr. Mordey was himself to blame.

ON THE CAPACITY AND RESIDUAL CHARGE OF DIELECTRICS AS AFFECTED BY TEMPERATURE AND TIME.*

BY J. HOPKINSON, F.R.S., AND E. WILSON.

(*Concluded from page* 863.)

All temperatures from 15° to 145° were obtained by heating the flask as mounted in fig. 1; for 200° to about 350° acid was taken away and a solder, melting at about 180° C., substituted. Since the solder only half filled the flask the conductivity should be about doubled for 200° to 350° when comparing with the lower temperatures.

Since $\frac{1}{c_t}$ is the conductivity of the jar at time t, let curves of conductivities be drawn in terms of times of contact in seconds. Fig. 7 gives these curves, which have been plotted from Table V. They show that, after a given time of contact, the effect of residual charge gradually diminishes as the temperature increases, until only the conductivity of the jar for infinite times is experienced. For instance, at about a temperature of 250° the table shows that the whole effect of residual charge has died away after 1/10,000 of a second. The total capacity of the jar at time t will be $\text{K} + \int_0^t \frac{1}{c}\,dt - \frac{1}{c_\infty}\,t$; where K is the instantaneous capacity which has been found by resonance to be = ·0005 microfarad for frequency 2×10^6.

K_1 = 118,000 divisions of the large slide condenser.

The curves in fig. 7 have been integrated, and their area up to ·0028 second, when reduced to microfarads and added to K, shows that,

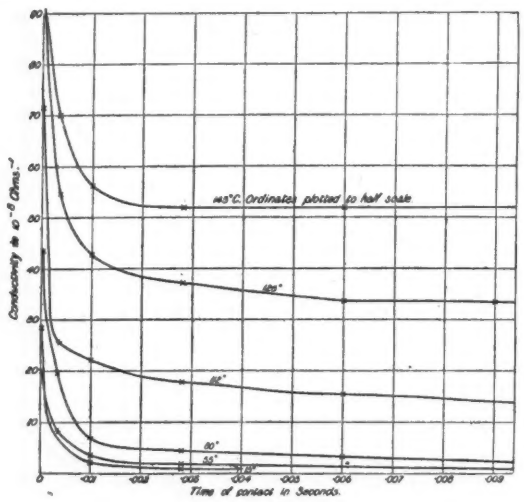


FIG. 7.

for time of contact ·0028 second, the total capacity, which is ·000588 at temperature 15·4°, is ·00087 at temperature 145°. This total capacity diminishes as the times of contact diminish, until we get to the results which resonance has shown; and then the capacity of this flask is sensibly the same for all temperatures when the frequency is of the order 2×10^6 per second.

ICE.

Ice was next examined, both in regard to its residual charge and its capacity. The residual charge is considerable, and increases as the temperature rises. Table VI. gives the residual charge of ice at two temperatures: the higher is produced by a freezing mixture of ice and salt, and is about − 18° C.; the lower by placing carbonic acid snow round the beaker, the whole being wrapped in thick felt. The apparent capacity depends on the frequency, as shown by the results in Table VII. At − 18° the capacity is twice as great with frequency 10 as with 77·6. At the lower temperature the capacity is greater for frequency 9 than for frequency 77·6, in the ratio 1·39 to unity.

The specific inductive capacity of ice was next determined, with a high frequency, by resonance: it was found to be about 3.* Decreasing the frequency to about 10,000 rendered the method by resonance less sensitive, but it is certain that the specific inductive capacity is, for this frequency, of the order 3 rather than 50. We conclude that the great deviation of ice from Maxwell's law is due to residual charge, which comes out between frequencies 10,000 and 100.

Our next step was to determine the resistance c, as in the case of glass, by the method shown in fig. 5. The platinum plates, fig. 2, were used, and to observe the temperature of the ice a platinum wire of resistance 1·32 ohms at 0° C. was frozen in the ice and surrounded the condenser. Table VIII. gives the results. K the capacity as given by the resonance experiments with frequency 2×10^6 was ·00022 microfarad. Adding to this $\int_0^t \frac{1}{c}\,dt - \frac{1}{c_\infty}\,t$, we find that at time ·0028 the total capacity is ·0038 at — 30° C., whereas it is for the same time ·0065 at — 18° C. The curves of conductivity are given in fig. 8, and show the same character of results as those in the case of glass, fig. 7.

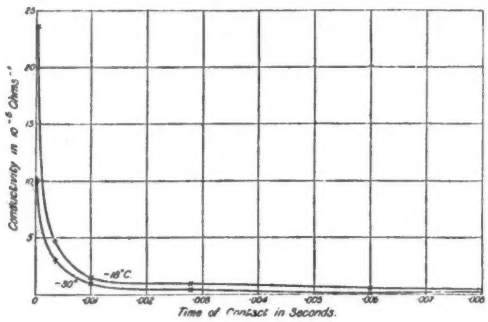


FIG. 8.

TABLE VI.

Time in seconds.	About − 18° C.	About −30°.	Remarks.
10	2,800	866	Charging volts 890. December 8th, 1894.
20	760	314	Duration of charge, ¼ minute in each case
60	377	74	Resistance at 945 volts
90	347	44	−18° C., $7{\cdot}2 \times 10^6$ ohms; −30°, $32{\cdot}5 \times 10^6$ ohms

TABLE VII.

December 8th, 1894, − 18° C. about.		December 8th, 1894, − 30° C. about.	
Frequency.	Capacity.	Frequency.	Capacity.
77·6	·01	77·6	·0072
10	·019	9	·01

[Added January 18th, 1897.]

CASTOR OIL.

This oil was obtained from Messrs. Hopkin and Williams, and was tested as supplied. The platinum plates, fig. 2, were submerged in

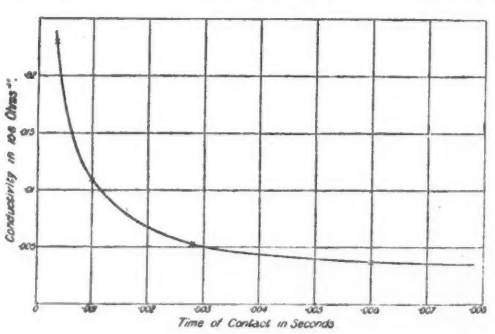


FIG. 9.

this oil. Resonance experiments give, for frequency 2×10^6, a capacity equal to 105 divisions on the large slide condenser. For long

* Royal Society Paper. Received December 15th, 1896—Read January 28th, 1897.

* Thwing finds 2·85 to 3·36; Blondlot 2; Perrot 2·04.

TABLE VIII.—Ice. November 5th, 1896.

a = Resistance box.
K_1 = ⅓rd $m.f.$
K_2 = Large slide condenser.
K = Instantaneous capacity of ice condenser = ·00022 $m.f.$ See Resonance, November 19th, 1895.

Time of contact.		Temperature of ice, − 18° C.								
Turns of milled head.	Time in seconds.	Large slide position K_2.	a in 10^6 ohms.	$\epsilon^{-\frac{t}{aK}} = A.$	Resistance of condenser c in 10^6 ohms. From $\frac{a+Ac}{a+c}$.	Resistance of condenser c in 10^6 ohms. From $a\frac{K_1}{K_2}$.	$\frac{1}{c}$ in 10^{-6}.	$\int\frac{1}{c}dt - \int\frac{1}{c_\alpha}t$. Area in square centims.	$\int\frac{1}{c}dt - \int\frac{1}{c_\alpha}t$. $m.f.$	$K + \int\frac{1}{c}dt - \frac{1}{c_\alpha}t$ in $m.f.$
0	·00002	430	·00019 ·00022*	10^{-200}	·0424	·0424	23·6			
½	·00035	430	·00096 ·0010*	...	·214	·214	4·67	16·8	·0034	·00362
1	·00099	430	·003 ·003*	...	·669	·669	1·49	25·15	·005	·00525
2	·0028	430	·0059 ·0060*	...	1·32	1·32	·758	31·4	00628	·00650
3	·006	430	·0078 ·0079*	...	1·74	1·74	·575	37·4	·0075	·00772
4	·009	430	·0095	...	2·12	2·12	·472	39·2	·0078	·00802
5	·011	430	·011	...	2·45	2·45	·408	40	008	·00822
			·011*	...	2·45*	2·45*				
6	·014	...	·011	...	2·45	2·45	·408	40	·008	·00822
7	...	...	·012	...	2·68	2·68	·373	40	·003	·00822
			·013*	...	2·90*	2·90*	·345*			
9	...	430	013*	...	2·90	2·90*	·345*	40	003	·00822

* The asterisk gives the result of a second experiment.

		Temperature of ice, − 32° C. to − 27° C.								
0	·00002	430	·00045	$1/7 \times 10^{-86}$	·100	·100	10			
½	·00035	430	·0015	...	·334	·334	2·99	9·3	·00186	·00208
1	·00099	430	·005	...	1·12	1·12	·893	14·2	·00284	·00306
2	·0028	430	·014	...	3·12	3·12	·320	17·9	·00358	·00380
3	·006	430	·021	...	4·68	4·68	·214	22·4	0045	·0047
4	·009	430	·0255	...	5·69	5·69	·176	23·9	·0048	·0050
5	·011	430								
6	·014	...	·032	...	7·13	7·13	·140	25·1	·0050	·0052
8	...	430	·039	...	8·7	8·7	·115			
10	...	...	·043	...	9·59	9·59	·104			
11	...	430	·045	...	10·0	10·0	·100			

TABLE IX.—CASTOR OIL.—November 16th, 1896.

K_1 = ⅓ microfarad condenser; K_2 = large slide condenser.
K = ·000287 microfarad from high frequency resonance experiment.

Time of contact.		Temperature of Castor oil, 6° C.								
Turns of milled head.	Time in seconds.	Large slide position K_2.	a in 10^6 ohms.	$\epsilon^{-\frac{t}{aK}} = A.$	Resistance of flask c in 10^6 ohms. From $\frac{a+Ac}{a+c}$.	Resistance of flask c in 10^6 ohms. From $a\frac{K_1}{K_2}$.	$\frac{1}{c}$ in 10^{-6} ($l^{-1}t$).	$\int\frac{1}{c}dt - \frac{1}{c_\alpha}t$. Area in square centims.	$\int\frac{1}{c}dt - \frac{1}{c_\alpha}t$. $m.f.$	$F = K + \int\frac{1}{c}dt - \frac{1}{c_\alpha}t$ in $m.f.$
0	·00002	430	·015	1/100	− 2·7	3·34	·3*			
½	·00035	160	·095	1/36 000	43·1	43·1	·023	6·2	·000025	·00031
1	·00099	40	·110	...	...	92·7	·0108	8·5	·000034	·00032
2	·0028	40	·223	...	...	188	·0053	12	·000048	·00033
3	·006	40	·320	...	...	270	·0037	14	·000056	·00034
5	·01	40	·460	...	...	388	·00258			
7	...	40	·620	...	...	523	·0019			
9	...	40	slightly greater than ·620							

* Taken from $a\frac{K_1}{K_2}$, since the negative value obtained from $\frac{a+Ac}{a+c}$ is untrustworthy, probably owing to K being still too large. To satisfy Maxwell's law, K should = ·000176 microfarad.

times the method was not that shown in fig. 3, but a bridge method, used in the earlier experiments,* in which a Ruhmkorff coil is used for exciting. This test gives 139 scale divisions on the same slide condenser. In air the plates have capacity 30 scale divisions. We see, therefore, that at frequency $2 + 10^6$ the specific inductive capacity would be 3·5 as against 4·63 for long times.

The short-time contact experiments, fig. 5, give the results in Table IX, the temperature of the oil being 6° C., from which we see that residual charge in this oil is considerable. The total capacity after time of contact ·006 second is ·00034; whereas, with high frequency by resonance, it is ·000287 microfarad. The curve in fig. 9 gives the relation between conductivity and time of contact, and has been plotted from Table IX.

* See *Proceedings* Roy. Soc., Vol. 43, p. 156.

GLYCERINE.

This glycerine was obtained from Messrs. Hopkin and Williams, and has been tested for purity and dried very carefully by Mr. Herbert Jackson, of the Chemical Department of King's College, London. The platinum plates, after careful cleaning in benzene, caustic-potash, and water were thoroughly dried and submerged in the glycerine in a beaker, the whole being placed in a glass receiver over a strong dehydrating agent. After exhaustion, just sufficient air was admitted to render the space inside sufficiently non-conducting to stop discharge between the terminals of the condenser which are sealed into glass tubes supported by an India-rubber stopper. The short-contact experiments show that the apparent resistance is 60,000 ohms, whether the time of contact be ·00002 or ·001 second, showing that there is no residual charge. The resonance experiments with high frequency give ·005 microfarad for the capacity with

glycerine, whereas with air the condenser had ·000082 capacity; the specific inductive capacity is, therefore, about 60. A test made as with castor oil with a Ruhmkorff at low frequency was difficult, but a fair approximation was made by introducing a suitable compensating leakage into one of the other condensers of the bridge.* The result indicated a capacity between 50 and 60.

WATER.

The platinum plates (fig. 2) were placed in ordinary distilled water in a beaker which was cooled to 0° C. by a surrounding brine solution composed of water, common salt and ice. The experiments with the short-contact apparatus show no material difference in the apparent resistance, whether the time of contact be ·00002 or ·00099 second: the apparent resistance for these times is 379 ohms. The effects of residual charge in water do not affect the resistance within the range of times of contact given by this apparatus.

[Added March 17th, 1897.]

OIL OF LAVENDER.

This oil was supplied by Messrs. Hopkin and Williams: it was tested with the short-contact apparatus, fig. 5, $K_1 = ·33$, $K_2 = ·0015$ microfarad. The charging potential was 1,250 volts; the following figures give the results:—

Time of contact in seconds	·00002	·00099	·0028	·006	·01
a in ohms	9,500	14,000	14,500	14,800	14,800

The high frequency resonance experiments give specific capacity 3·89: the frequency being of the order 2×10^6.

Two experiments were made at low frequency. First, the bridge method, fig. 3, which gives the following results, the temperature of the oil being 16° C.:—

Frequency.	Charging volts.	Specific capacity.
18	65	5·6
79	30	4·34

Second, the bridge method with Ruhmkorff coil as used in the castor oil experiments. Temperature 14° C. Specific capacity 4·18.

Experiments have been made by Stankewitsch (*Wied. Ann.*, 52), showing a variable capacity for oil of lavender. We, however, have not succeeded in obtaining any result so high as his.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

13,937. "Electrical and automatic registering indicator and recorder." G. B. HAMILTON. Dated June 8th.

13,938. "Improvements in holders for shades and the like applicable to gas and electric light fittings." F. SMALL and T. CLARKE. Dated June 8th.

13,592. "A channel arm for telegraph insulators." A. WILMOT and F. HARE. Dated June 8th.

13,959. "Improvements in electric ship log apparatus." A. G. BROOKES. (W. H. McCurdy, United States.) Dated June 8th.

13,970. "Improvements in and relating to dynamo-electric machines and rotary converters." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (E. W. Rice, Jun., United States.) Dated June 8th. (*Complete.*)

13,971. "Improvements in and relating to controllers for electric motor circuits." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. E. D. Priest, United States.) Dated June 8th. (*Complete.*)

13,972. "Improvements in and relating to controllers for electric motor circuits, and in blow out magnets for use with same." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (W. B. Potter and F. E. Case, United States.) Dated June 8th. (*Complete.*)

13,973. "Improvements in and relating to pneumatically actuated 'open circuit' controllers for electric motors." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (E. D. Priest and F. A. Merrick, United States.) Dated June 8th.

13,974. "Improvements in lightning arresters." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (Axel Ekstrom, United States.) Dated June 8th.

13,975. "An improved electrical bond or connection for railway and like rails." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (W. B. Potter, United States.) Dated June 8th.

13,976. "Improvements in or relating to induction motors." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (C. P. Steinmetz, United States.) Dated June 8th.

13,977. "Improvements in three-phase alternating current induction meters." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (C. P. Steinmetz, United States.) Dated June 8th. (*Complete.*)

13,992. "Improvements in anodes for electrolytic cells." W. MATHER. Dated June 8th.

14,022. "New electric furnace for the manufacture of carbide of calcium with continuous operation, and with water covering for the gas." R. MEMMO. Dated June 8th.

14,024. "Improvements in or relating to direct current dynamos and electromotors." F. H. DAVIES and C. O. BASTIAN. Dated June 8th.

14,033. "Improvements in electric regulators." C. C. GARTLAND. Dated June 8th. (*Complete.*)

14,077. "Improvements relating to electric traction." H. V. MOREAU. Dated June 9th.

14,085. "Improved means for producing continuous current-effects from alternating electric current generators." O. BEHREND. Dated June 8th.

14,111. "Electric contact devices for automatic regulators." G. K. B. ELPHINSTONE. Dated June 10th.

14,136. "Improvements in or relating to coin freed mechanism and machines for giving electric shocks." F. Ashburner. Dated June 10th.

14,187. "Improvements relating to telephonic conductors." H. H. LAKE. (Emil Von Szvetics Hingary). Dated June 10th.

14,198. "Improvements in or connected with electric arc lamps." F. S. WORSLEY. Dated June 10th.

14,207. "A new or improved electricity supply meter." R. KENNEDY. Dated June 11th.

14,222. "Improved method of transmitting so called electrical energy through non-conducting media without intervening conductors for signalling or otherwise." D. R. JONES and J. H. JACKSON. Dated June 11th.

14,247. "Improvements in and relating to electric furnaces." W. P. THOMPSON. (La Societa Italiana dei Forni Electrici, Italy.) Dated June 11th. (*Complete.*)

14,252. "Improvements in mechanism for electric traction systems in which the electric current is supplied to the cars or locomotives from studs, sections of rails or the like laid in the road."

14,253. "An improved alternating current meter." C. RAAB. Dated June 11th. (*Complete.*)

14,254. "Improvements in or relating to ampere-hour electric meters." G. HUMMEL. Dated June 11th.

14,272. "Improvements in the manufacture of casing compounds for electric insulating and other purposes. P. H. HANSEN and J. K. WESTENGAARD. Dated June 11th. (*Complete.*)

14,278. "An improved electric arc lamp." A. LEHMANN and A. MANN. Dated June 11th,

14,330. "A method of producing a magnetic current of force having a displacement of phase equal to 90° or more relatively to the tension of the magnetising current." J. Y. JOHNSON. (Messrs. Hartman & Braun, Germany.) Dated June 12th. (*Complete.*)

14,340. "Improvements in or relating to incandescent electric lamps," H. S. MAXIM. Dated June 12th.

14,341. "Improvements in machines for making carbons for electrical purposes." H. H. LAKE. (T. B. Dooley, United States.) Date June 12th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

4,179. "Improvements in electric road vehicles actuated by electricity." I. MACHIN. Dated February 25th, 1896. Consists in an arrangement of a cradle mounted on trunnions for carrying the accumulators and a trough shaped channel for holding the wires which conduct the current from the batteries to the motors. 3 claims.

8,853. "A new or improved construction or arrangement of generator of electricity." H. ABZT. Dated April 27th, 1896. Relates to an appliance for the generation of electricity without expenditure of heat, mechanical labour, or the application of chemical materials in a purely physical manner as the outcome of terrestrial motive force in the form of two currents. The scope of the invention will be best understood from the claim which is for the application of vacuum chambers consisting of several cells each with a vacuum in a vacuum, and a vacuum over a vacuum for the purpose of effecting the conversion of power (conversion of the natural atmospheric pressure, or, by means of a mouth and suitable contrivances for pressure, of artificially increased air, gas, or hydraulic pressure) into electric fluid. 3 claims.

* This appears to have been done by Nernst, Physical Society's *Abstracts*, Vol. 1, p. 38.

VOL. XL. No. 1,022. [All Rights Reserved.] JUNE 25, 1897. [Registered at G.P.O. as a Newspaper.] PRICE FOURPENCE.

ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—SUBSCRIPTION per annum, Postage inclusive, in Great Britain, 19s. 6d.; to all other Countries, 24s.—NEW YORK: D. VAN NOSTRAND, 23, Murray Street, and 27, Warren Street. PARIS: Madame VEUVE J. BOYVEAU, Librairie Etrangère, 22, Rue de la Banque. BERLIN: A. ASHER AND CO., 5, Unter den Linden.

Telegraphic Address, "Ageekay, London." A B C Code. Telephone No. 6,933.

GENERAL LIBRARY, UNIV. OF MICH. JUL 6 1897

WE HOLD THE

HIGH TENSION RECORD!!

READ THIS AND NOTE:

"After paying interest and redemption fund on the loan and all expenses, there is a net profit of £1,628 9s. 3d., which I am proud to say is a unique record for any town, and the Council have cause to congratulate themselves that they have the honour of being the only town, working on the high tension system, that have not made a call upon the rates in their first completed year's working."

REPORT OF BOROUGH ELECTRICAL ENGINEER TUNBRIDGE WELLS.

ALL THE GENERATING PLANT WAS SUPPLIED BY

JOHNSON & PHILLIPS,

VICTORIA WORKS, OLD CHARLTON, KENT,

And 14, UNION COURT, OLD BROAD STREET, LONDON, E.C.

219

W. T. GLOVER & Co.,

(Henry Edmunds and Godfrey E. Samuelson),

Telegrams:—"GLOVERS," SALFORD. "PHONOSCOPE," LONDON. **SALFORD, MANCHESTER.** Telephone Nos.:—Manchester, 1,187. London, 3,101.

MAKERS OF EVERY DESCRIPTION OF

TELEGRAPHIC, TELEPHONIC AND ELECTRIC LIGHT WIRE AND CABLE.

LEAD COVERED & ARMOURED • CABLES. •

SPECIAL CONCENTRIC CABLES.

"DIATRINE,"

THE BEST NON-RUBBER INSULATION IN THE MARKET.

Sole Makers of PATENT **"DIATRINE,"**

• CABLES, •

Suitable for High or Low Tension.

MAINS FOR

TOWN LIGHTING, &c.

High Insulation & Great Durability.

• ANTI-INDUCTION AND METALLIC CIRCUIT TELEPHONE CABLES.

Any number of Wires for Aerial & Underground Work.

PATENTEES & SOLE MANUFACTURERS OF COMPRESSED SOLID ENDED

• ARMATURE BARS. •

COMPACTUM" COVERED DYNAMO WIRE & CABLE.

ELECTRIC ORGAN CABLES, Up to 2,000 Wires.

COMPRESSED STRAND (Crompton's Twist) For Armature Winding.

London Address:—39, Victoria St., Westminster, S.W. 10101

NEWCASTLE-ON-TYNE:—Imperial Buildings, Westgate Road. BRUSSELS:—7, Rue de la Pepiniere.

THE

"NATIONAL" GAS AND OIL ENGINES.

Improved "Otto"

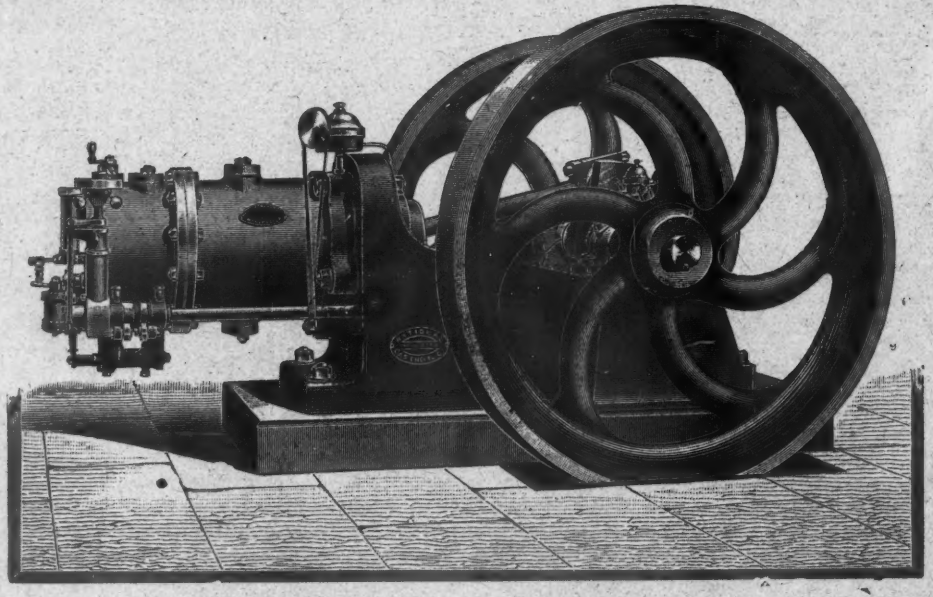
Simple.

Silent.

Economical.

Reliable.

Thousands at work.



ENGINES SPECIALLY CONSTRUCTED FOR ELECTRIC LIGHT.
SELF-STARTERS TO ALL LARGE SIZES. ONE HUNDRED ALWAYS IN PROCESS.

Write for Testimonials and Prices to the

"NATIONAL" GAS ENGINE CO., Ltd.,

ASHTON-UNDER-LYNE.

a817

TELEPHONE 4,740

WORKS: CASTLE STREET.

WILLCOX'S

WILLCOX'S SPECIAL LUBRICATINC OILS

FOR ELECTRIC LIGHT STATIONS.

WILLCOX'S CYLINDER OIL.
WILLCOX'S DYNAMO OIL.
WILLCOX'S CRANK CHAMBER OIL.
WILLCOX'S CASTOR OIL.

OUR OILS ARE USED BY THE PRINCIPAL ELECTRIC LIGHT COMPANIES.

SEND FOR OUR NEW OIL LIST.

W. H. WILLCOX & CO., OIL REFINERS,

GENERAL ENGINEERS' STORES.

34 & 36, SOUTHWARK STREET, LONDON.

8081

F. WIGGINS & SONS, 10, TOWER HILL, E., and 102 & 108, MINORIES, E.C., LONDON.
MICA MERCHANTS, [Telephone No. 2,348 Avenue.]
Manufacturers of MICA GOODS for ELECTRICAL and ALL purposes.
CONTRACTORS TO HER MAJESTY'S GOVERNMENT. 6100

MICA

THE UNITED ASBESTOS Co. LIMITED

PIONEERS OF THE ASBESTOS TRADE.

The ONLY COMPANY in the World owning and working Asbestos Mines in both ITALY and CANADA.

Manufacturers of every class of Asbestos Goods.

Special attention is drawn to the following new Application:—

THE UNITED ASBESTOS PATENT "SALAMANDER" DECORATIONS.
Novel Application of Asbestos in Embossed Wall Decorations.
Designs by Leading Artists, capable of infinite variety of Decorative Treatment. Fireproof.
Prices and Particulars on application to West End Depot, 158 & 160, CHARING CROSS RD., LONDON, W.C.

DOCK HOUSE, BILLITER ST., LONDON, E.C.

All Goods are made at our Works, near London, and are of the best possible description.

Specify "SALAMANDER" Brand.

Depôts: NEWCASTLE-ON-TYNE, Quay MANCHESTER, 24, Deansgate; LIVERPOOL, 25, James Street; GLASGOW, 96, Bothwell Street; CARDIFF, 125, Bute Street; BRISTOL, Provident Buildings, Clare Street; ST. PETERSBURG, Gostinoe Dvor (Interior) No. 51; ANTWERP Rue Montevideo. 6347

FREDERICK SMITH & Co., WIRE MANUFACTURERS, LTD.

CALEDONIA WORKS, HALIFAX,
Contractors to H.M. Government and Railway Companies.

Patent Galvanised Telegraph Wire (100-lb. Coils)
TO ALL SPECIFICATIONS.

COPPER WIRE (100 PER CENT. CONDUCTIVITY.)

Plain Soft. Hard Drawn for Telephone Lines. Special Tinned Wire.
SILICIUM BRONZE WIRE (Weiller's Patent under License). 1854

Wm. M. FOXCROFT,

(*Successor to the late W. Foxcroft, also F. Lucas*),

Telegraph and Telephone Case Manufacturer,

36, PERCIVAL STREET, & 9, SMITH STREET,

CLERKENWELL, LONDON, E.C.

Offices—PERCIVAL STREET).

EVERY DESCRIPTION OF CABINET WORK for ELECTRIC LIGHT ENGINEERS

Lock and Block, Single Needle, Bell, Sounder, Perforator, Photometer, Telephone Cases, Battery Boxes, &c., &c.

PRIZE MEDALS, LONDON, 1851; PARIS, 1881. 201

D. H. BONNELLA & SON,

IVORY, BONE, HORN, AND WOOD TURNERS.

Manufacturers of
BELL PUSHES, INDICATORS, BELLS, SWITCH BLOCKS.
Name and Address Tablets. X Ray Apparatus.
INCANDESCENT LAMPS. FLAME LAMPS a Specialité.
Electric Light Bell and Telephone Fittings of every description.

58, MORTIMER STREET, LONDON, W.
Steam Works: 43 & 45, KIRBY ST., HATTON GARDEN.

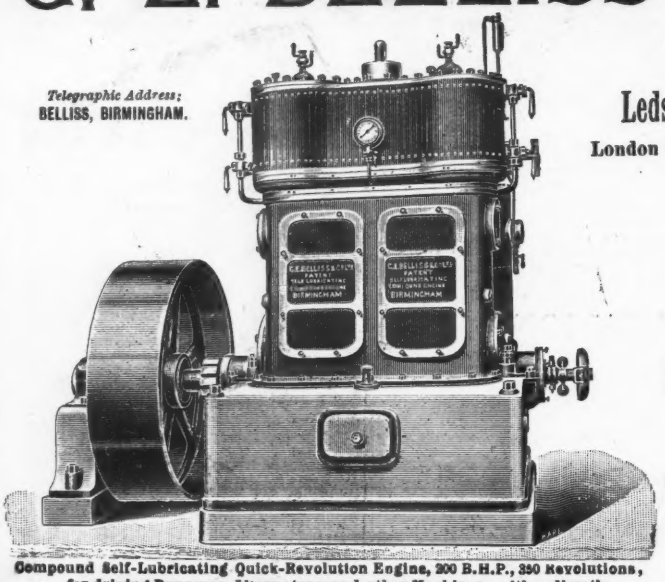
REMOVAL.—FAIRFAX & WETTER, Patent and Trade Mark Agents, and Consulting Engineers, have Removed to 37 & 39, Essex St., Strand, London. Amendments, Oppositions, Reports. 6805

G. E. BELLISS & CO., LTD.,

(Established 1852),

ENGINEERS.

Telegraphic Address: BELLISS, BIRMINGHAM.



Compound Self-Lubricating Quick-Revolution Engine, 200 B.H.P., 330 Revolutions, for driving Dynamos, Alternators, and other Machinery, either directly coupled, or by rope or belt transmission as above.

Ledsam Street Works, **BIRMINGHAM.**

London Office: Westminster Chambers, 9, Victoria St., S.W.

MANUFACTURERS OF

Double-Acting, Quick-Revolution Vertical

ENGINES,

SIMPLE and COMPOUND, OPEN and ENCLOSED

FOR

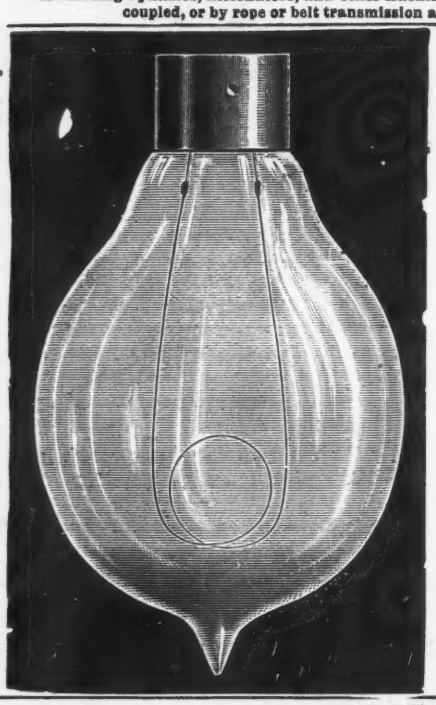
ELECTRIC LIGHTING,

INDEPENDENT CONDENSING PLANTS, AIR AND CIRCULATING PUMPS.

Speciality: Self-Lubricating Quick-Revolution Engines, One, Two or Three Cranks, of any Power.

BEFORE ORDERING WRITE FOR CATALOGUES.

THE ENGINEERING TELEGRAPH CODE USED. 9884



Telegrams: "Braulik, London

G. BRAULIK.

Established over 10 years.

Telephone No. 15,075

217 & 218, UPPER THAMES STREET.

INCANDESCENT LAMPS,

Messrs. PHILIPS & CO.,

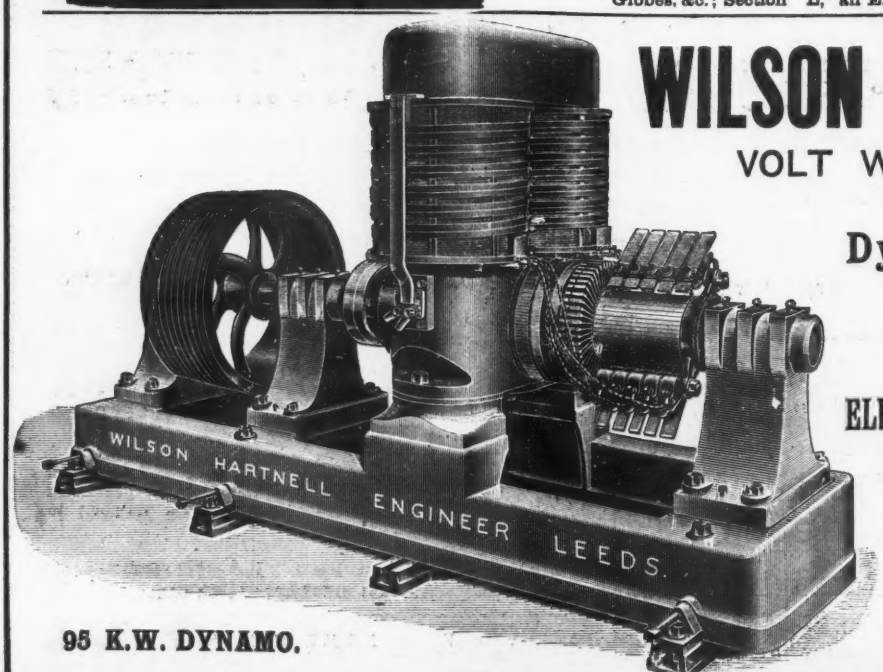
THE "LONDON" LAMP,

Specially made for the English market.
Immense stock kept at above premises. All candle powers and voltages.

SPECIALITIES.—Thoroughly efficient high-voltage single-filament lamps. Lamps for ships' use, and for factories, mines, damp climates, &c., with metallic cap joint without plaster or cement.

For long life, efficiency, cheapness, and all round excellence the "LONDON" lamp is unsurpassed. Special prices for large contracts, to be ascertained on application.

Ask for NEW LISTS:—Section "B," Bells, Indicators, &c., &c.; Section T, Telephones, Medical Coils, Telegraph Instruments, &c.; Section "A," Arc Lamps Globes, &c.; Section "L," all Electric Light Accessories.



95 K.W. DYNAMO.

WILSON HARTNELL

VOLT WORKS, LEEDS,

MANUFACTURER OF

Dynamos, Motors, Switchboards,

PLANTS FOR ELECTRICAL TRANSMISSION OF POWER,

PUMPING, HAULING, HOISTS, &c.

ESTIMATES FREE.

Telegrams: "HARTNELL, LEEDS."
Telephone 282. 12134

Burns with economy
Singly on 100 volt circuits.
2 in Series on 200 volts, &c.

Sizes: 2½, 4, 5, 6, and 7 amperes.

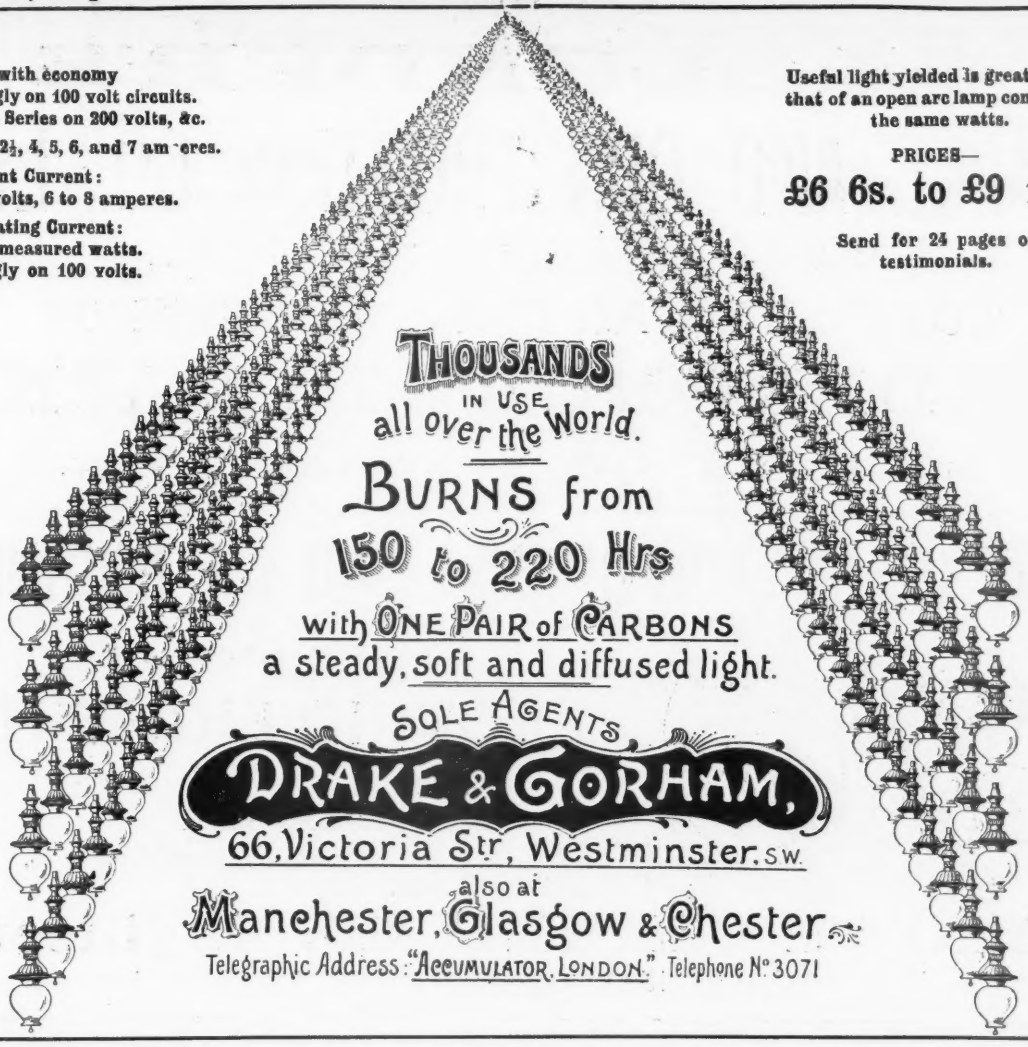
Constant Current:
75 volts, 6 to 8 amperes.

Alternating Current:
580 measured watts.
Singly on 100 volts.

Useful light yielded is greater than that of an open arc lamp consuming the same watts.

PRICES—
£6 6s. to £9 15s.

Send for 24 pages of testimonials.



THOUSANDS
IN USE
all over the World.

BURNS from
150 to 220 Hrs
with ONE PAIR of CARBONS
a steady, soft and diffused light.

SOLE AGENTS,
DRAKE & GORHAM,
66, Victoria Str, Westminster, S.W.
also at
Manchester, Glasgow & Chester.
Telegraphic Address: "ACCUMULATOR, LONDON." Telephone No. 3071

Telegrams
"ELECTRIC, LONDON."

THE

TELEPHONE No. 103.

LONDON ELECTRIC WIRE COMPANY,

LIMITED.

ANCHOR WORKS, PLAYHOUSE YARD,
GOLDEN LANE, LONDON, E.C.

MANUFACTURERS OF

COVERED WIRES OF ALL DESCRIPTIONS

For Electrical Instrument Dynamo Machines, Telephones and Electric Bells.

CABLES OF LIGHT MEDIUM AND HIGH INSULATION FOR ELECTRIC LIGHT MAINS AND BRANCH CIRCUITS.

FLEXIBLE CABLES AND CORDS OF ALL DESCRIPTIONS.

CONTRACTORS to the various GOVERNMENT DEPARTMENTS

And to the Leading Electric Light and Telephone Companies.

PLATINOID WIRE FOR HIGH RESISTANCES

(MARTINO'S PATENT).

The Specific Resistance of Platinoid is 50 per cent. higher than that of the best German Silver. Its temperature coefficient is lower than that of any other metal used for Electrical purposes. It is uniform in quality, and does not tarnish under atmospheric influences. During the past six years some of the largest Electric Light Companies have adopted Platinoid for Resistances, to the entire exclusion of German Silver.

Sole Agents for Platinoid for all Electrical Purposes (By Agreement with the Patentee),

The LONDON ELECTRIC WIRE COMPANY, Ltd.

PRICE LISTS ON APPLICATION.

CALLENDER'S

CABLE AND CONSTRUCTION CO., LTD.,

90, CANNON STREET, LONDON, E.C.,

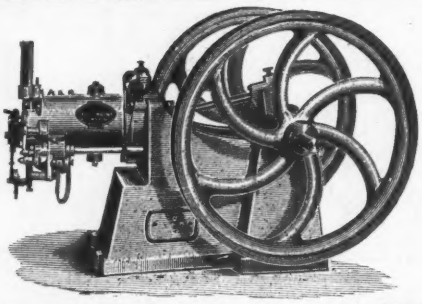
CONTRACTORS FOR COMPLETE SYSTEMS OF

UNDERGROUND MAINS

FOR

LIGHTING AND TRACTION WORK.

DOUGILL'S "OTTO" GAS AND OIL ENGINES



Specially adapted for

ELECTRIC LIGHTING.

SILENT,
SIMPLE, and
ECONOMICAL.

Awarded Ten Gold Medals.

PRICE & CORNEILLE, Engineers,

Telegrams:—
"PROCLINO," LONDON.

15, VICTORIA STREET, LONDON, S.W. a1000

THE

BRITISH INSULATED WIRE CO., LTD.,

PRESCOT, LANCASHIRE.

PAPER INSULATED CABLES

FOR

ELECTRIC LIGHTING.
TRANSMISSION OF POWER.
TELEPHONES.
TELEGRAPHS.
HOUSE WIRE.

Our Cables are now in use by over

SEVENTY

of the Electricity Supply Works in the United Kingdom. 9852

McDOUGALL'S PATENT MECHANICAL STOKER.

Fire-doors are of ordinary hand-firing construction, so that, in case of need, hand-firing can be resorted to immediately, just the same as under ordinary circumstances.

THE CHEAPEST AND BEST MACHINE IN THE MARKET.

PLEASE SEND FOR LATEST REPORTS AND TESTS.

McDOUGALL'S PATENT OIL SEPARATOR AND EXTRACTOR

Prevents the deposit of Oil on Boiler Furnaces.

NO FILTERING MEDIUM EMPLOYED.
NO BY-PASS REQUIRED.

Cheap and Effective.

W. B. HAIGH & CO., Ltd.,
Globe Iron Works, OLDHAM.

Telegrams: "HAIGH, OLDHAM."

Agents Wanted where not represented. 10219

"ELECTRA."

AN ILLUSTRATED MONTHLY JOURNAL, UNDER THE MANAGEMENT OF

Mr. G. C. J. VERKERK.

This periodical is the only journal devoted to electrical matters published in Holland, and is particularly suitable for advertising purposes.

EDITED BY

SCHELTEMA, HOLKEMA'S BOEKHANDEL,
AMSTERDAM.

The publishers will be happy to send prices and full particulars. 1057

W. MIDDLEMISS,

Nesfield Street, BRADFORD,

Manufacturer of all kinds of

WOODWORK FOR ELECTRICIANS.

Quotations given, on receipt of Drawings or Samples, for Articles in OAK, TEAK, MAHOGANY, WALNUT or WHITEWOOD.

I have a large stock of dry wood, and over 20 wood-working machines of the most modern types. a480

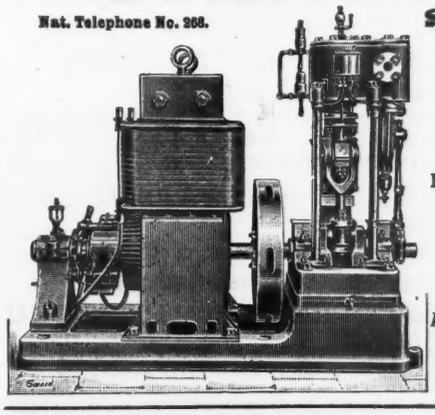
THE SUNDERLAND FORGE & ENGINEERING CO. LTD.

ELECTRICAL AND GENERAL ENGINEERS AND FORGEMASTERS,

Nat. Telephone No. 268.

SUNDERLAND.

London Address:—110, FENCHURCH ST., E.C. Glasgow Address:—12, RENFIELD STREET.



Dynamos, Motors, Combined Plants.

Ship Lighting, Installations, Switchboards.

Electric Cranes, Hoists, Pumps, Fans, Haulage and Winding Gears.

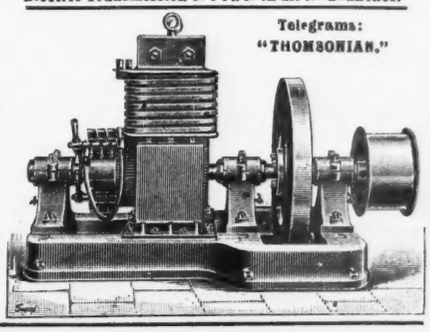
High Speed Engines, Simple, Compound, and Triple Expansion.

Auxiliary Machinery, for Ships, of all Description.

Ship and Engine Forgings up to 20 Tons. a405

Electric Transmission of Power in all its Branches.

Telegrams: "THOMSONIAN."



CONCENTRIC WIRING

FOR BUILDINGS AND SHIPS.

NO COMPETITION WITH TRADE CUSTOMERS.

J. D. F. ANDREWS & CO.,

BY PUTNEY BRIDGE STATION, LONDON, S.W. a651

ANDREWS' PATENT

LONG LIFE ARC LAMP.

THE PIONEER of ENGLAND. a705

NOW READY. 75 Illustrations. Post Free 7s. 6d.

APPLIED MAGNETISM:

AN INTRODUCTION TO THE DESIGN OF ELECTRO-MAGNETIC APPARATUS

By J. A. KINGDON, B.A.

H. ALABASTER, GATEHOUSE & CO., 22, Paternoster Row, London, E.C.

BEST WIRE

FOR

OVERHEAD TELEPHONE & TELEGRAPH LINES

And all Electrical Purposes.

SILICIUM BRONZE

PHOSPHOR BRONZE

GUN METAL AND
PHOSPHOR BRONZE
CASTINGS.

Phosphor Bronze Wire, Rods, Sheets, &c.; Bearings, Bushes, and other wearing parts of Machinery. Babbitt's and other White Anti-Friction Metals.

Patent Silicium Bronze Wire of great tensile strength and high conductivity. H.C. and ordinary Copper Wire. Rolled and Drawn German-Silver and Brass.

PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL

SOLE LICENSEES
FOR
BULL'S METAL,
FOR
CASTINGS, FORGINGS, RODS, SHEETS, AND STAMPINGS.

8897

THE PHOSPHOR BRONZE COMPANY, Limited, 87, Sumner St., Southwark, LONDON, S.E.

REID BROTHERS.

12, Wharf Road, City Road, London, N.,

TELEGRAPH AND PNEUMATIC ENGINEERS AND CONTRACTORS

FOR THE SUPPLYING, ERECTING, LAYING DOWN, AND MAINTENANCE OF OVERHEAD AND UNDERGROUND WIRES FOR

TELEGRAPHS AND ELECTRIC LIGHTING.

COMPLETE ELECTRIC LIGHT INSTALLATIONS.

PNEUMATIC TUBES FOR THE TRANSMISSION OF PAPERS, &c.,

FITTED WITH ENGINES AND PUMPS COMPLETE.

REID BROS.' "PATENT" PNEUMATIC CASH SYSTEM for the transmission of COINS. &c.

Makers of Radcliffe's Patent Electrical Signal-Locking Apparatus, and Patent Electrical Passenger and Guard Communication.

CONTRACTORS TO H.M. GOVERNMENT FOR SUBMARINE MINING APPARATUS AND ALL ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.

Manufacturers of Submarine Cables, Wire, Iron Poles, Instruments, Batteries, Insulators and Stores of every Description. 422

BENHAM & FROUD LTD.,

ART METAL WORKERS & MANUFACTURERS of

ELECTRIC LIGHT FITTINGS.

CHANDOS WORKS (Established A·D·1785·) CHANDOS STREET LONDON. W.C.

THE "VANBE" ARC LAMP.

IN-DOOR OR OUT-DOOR.

Absolutely the best lamp made.

Adjustment perfect. Feed imperceptible.

In use at the Royal Arsenal, General Post Office, &c.

Self-focussing, simple, everlasting.

Unequalled for finish and workmanship.

The only single carbon 20-hour lamp on the market.

This lamp is made entirely at our works in Kirby Street, London.

SOLE MAKERS,

VAUGHAN & BROWN, LTD.,

15, 16, & 17, KIRBY STREET, LONDON, E.C. 10391

INDEX TO ADVERTISEMENTS.

The names of Advertisers, whose announcements are ordered for a series, are entered under any one Heading in this Index free of Charge, but if repeated under other headings, 6d. per week is charged for each additional entry.

Accumulators— PAGE
Charging .. .. *Sup.* 10
Chloride Electrical Storage Syndicate .. 19
Drake & Gorham 5
Edison & Swan United E. L. Co., Ltd... 11
Electrical Power Storage Company .. 13
Epstein Accumulator Company 23
Lamina Accumulator Company 16
A. B. Pescatore 17
A. J. Wright .. ..

Aluminium—
British Aluminium Company 13

Arc Lamps— J. D. F. Andrews & Co. .. 7
F. Borland .. ..
G. Braulik 4
Brockie-Pell Arc Lamp, Ltd. .. *Sup.* 6
Crompton & Co. .. .. .. *Sup.* 16
Drake & Gorham 5
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Company, Limited *Sup.* 8
Johnson & Phillips .. ..1 & 19
A. W. Richardson .. ..
Stewart Electrical Syndicate, Ltd. *Sup.* 11
Vaughan & Brown, Ltd. 9
Wilhelm & Co. .. ..

Asbestos— United Asbestos Company .. 3

Auctioneers & Valuers (Mechanical)—
Wheatley Kirk, Price & Goulty .. *Sup.* 9

Batteries—
D. P. Battery Company, Limited ..
Edison & Swan U. E. L. Co., Ltd. .. 11
Gen. Elec. Co., Ltd. .. .. .. *Sup.* 8
India-Rubber Company 24
Johnson & Phillips .. ..1 & 19
Telegraph Manufacturing Company *Sup.* 1
Williamson & Joseph, Ltd. .. *Sup.* 7

Battery Jars— Doulton & Co. .. *Sup.* 12
J. Stiff & Sons .. ..

Bells—
Consolidated Telephone Cn. & M. Co. ..
General Electric Company, Limited *Sup.* 8
Williamson & Joseph, Ltd. .. *Sup.* 7

Belting— J. Hendry .. .. .. *Sup.* 14
Webb & Son .. .. *Sup.* 4

Boiler Mountings and Valves—
Hopkinson & Co. 12

Books— Smith, Elder & Co. .. .. ..
E. & F. N. Spon 20

Cabinet Work—
Consolidated Telephone Cn. & M. Co...
W. M. Forcroft 3
W. Middlemiss 7

Carbons— Brockie Pell Arc Lamp, Ltd. *Sup.* 6
Carbon Syndicate, Limited .. *Sup.* 11
Edison & Swan U. E. L. Co., Ltd. .. 11

Carbons—*Continued.* PAGE
Gen. Elec. Co. Ltd. .. .. .. *Sup.* 8
Johnson & Phillips .. ..1 & 19

Castings—
Phosphor Bronze Company 8

Chemicals—
G. Boor & Co... .. ..

Clutches—
Cowlishaw, Walker & Co... .. *Sup.* 14

Crucibles, Plumbago—
Doulton & Co. .. .. .. *Sup.* 12

Dynamos—
Crompton & Co. .. .. .. *Sup.* 16
Crypto Co. 21
Edison & Swan U. E. L. Co., Ltd. .. 11
The Electrical Co., Ltd. .. .. ..
L. Gardner & Sons .. .. .. *Sup.* 4
General Electric Company, Limited *Sup.* 8
Greenwood & Batley 23
W. B. Haigh & Co. 7
Wilson Hartnell 4
J. H. Holmes & Co. .. .. .. *Sup.* 9
Johnson & Phillips .. ..1 & 19
Laurence, Scott & Co. .. .. ..
McClure & Whitfield .. ..
Muirhead & Co. .. .. .. *Sup.* 4
Newton Electrical Engineering Works..
Phœnix Dynamo Manufacturing Co. *Sup.* 4
Rosling & Appleby (2nd Friday) .. ..
D. Stewart & Co., Ltd. 10
Ernest Scott & Mountain 21
Sunderland Forge Co., Ltd. 7

Dynamo Brushes—
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Company, Limited *Sup.* 8
Johnson, Clapham & Morris .. ..
W. Patterson .. ..
Potter & Co. .. ..

Ebonite—
Harburg India-Rubber Comb Co. *Sup.* 9
D. Moseley & Sons .. ..

Electrical Engineers and Contractors—
G. E. Belliss & Co., Ltd. 4
British Thomson-Houston, Ltd. .. 18
Brush Electrical Engineering Company 12
Callender's Cable and Construction Co. 6
Clarke, Chapman & Co. .. .. *Sup.* 15
Crompton & Co. .. .. .. *Sup.* 16
Drake & Gorham 5
Easton, Anderson & Goolden 18
Electric Construction Company .. *Sup.* 2
J. Fowler & Co., Limited .. .. ..
J. P. Hall & Co. .. ..
India-Rubber & Telegraph Works Co... 24
Johnson & Phillips .. ..1 & 19
C. A. Parsons & Co. .. ..
Phœnix Dynamo Mfg. Co. .. *Sup.* 4

Electrical Engineers, &c.—*Cont.* PAGE
Pyke, Harris & Co. .. ..
Reid Bros. 8
Ernest Scott & Mountain 25
Siemens Bros. & Co... 14
Telegraph Manufacturing Company *Sup.* 1
Western Electric Company .. *Sup.* 16
Westinghouse Electric Co. 23

Electric Light Fittings—
Benham & Froud 8
Best & Lloyd .. ..
Dorman & Smith 9
Edison & Swan U. E. L. Co., Ltd. .. 11
Evered & Co. .. ..
Faraday & Son 12
Genl. Elec. Co., Ltd. .. .. *Sup.* 8
Hopkins, A. & W. .. .. .. *Sup.* 16
G. Jaeger .. .. *Sup.* 11
A. P. Lundberg 20
H. M. Salmony & Co. .. .. ..
G. Stegmann .. ..
Tucker & Co. .. ..
Vandam & Co... .. .. .. *Sup.* 11
B. Verity & Sons .. .. .. *Sup.* 1
Waltham Electric Engineering Co. *Sup.* 11
Williamson & Joseph, Ltd. .. *Sup.* 7

Electricity Meters—
Chamberlain & Hookham .. *Sup.* 14
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Company, Limited *Sup.* 8
Johnson & Phillips .. ..1 & 19

Engines for Electric Light—
G. E. Belliss & Co. 4
Browett, Lindley & Co. .. .. ..
L. Gardner & Sons .. .. .. *Sup.* 4
Price & Cornellie 6
National Gas Engine Co. 3
Ransomes, Sims & Jefferies .. ..
Stephenson & Co. 10
D. Stewart & Co., Ltd. 10
Willans & Robinson.. .. .. *Sup.* 15

Engine Fittings—
W. H. Bailey & Co. 21

Fibre—
Delaware Hard Fibre Company .. *Sup.* 10
David Moseley & Sons .. .. ..
Mosses & Mitchell .. ..
Williamson & Joseph, Ltd. .. *Sup.* 7

Fire Insurance—
Phœnix Office.. .. ..

Forgings— R. Jenkins .. .. .. *Sup.* 11

Fuel Economiser—
E. Green & Son, Limited .. .. ..

Furnaces— Meldrum Bros. .. .. *Sup.* 6

(Continued on next Page.)

INDEX TO ADVERTISEMENTS.

(Continued from previous Page.)

Generators— PAGE
Cox Thermo-Electric Company 21

Glass—
Brockie-Pell Arc Lamp, Ltd. .. *Sup.* 6
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Co., Ltd.. .. *Sup.* 8
Williamson & Joseph, Ltd. .. *Sup.* 7

Incandescence Lamps—
Berend & Co. .. ..
G. Braulik 4
Brush Electrical Engineering Co. .. 12
Cruto Incandescent Lamp Agency ..
Edison & Swan United E. L. Co., Ltd.. 11
Fuller & Co. .. .. *Sup.* 14
General Electric Co., Ltd... .. *Sup.* 8
Hard Incan. Lamp Co. .. .. ..
Hopkins, A. & W. .. .. .. *Sup.* 16
Lyell & Co. .. .. *Sup.* 13
Mackey, Mackey & Co. 20
O. Scholzig .. ..
Siemens & Co... 14
Sunbeam Lamp Company.. .. ..
Williamson & Joseph, Ltd. .. *Sup.* 7
Zürich Incandescence Lamp Co. ..

India-Rubber—
India-Rubber, G. P. & Tel. Works Co. .. 24

Institutions—
Electrical & General Engineering Col...

Instrument Manufacturers—
Consolidated Telephone Cn. & M. Co. ..
Edison & Swan U. E. L. Co., Ltd. .. 11
Elliott Bros. .. ..
Nalder Bros. & Thompson.. .. ..
Paul .. .. *Sup.* 12
Strube .. ..
James White .. .. *Sup.* 3
Williamson & Joseph, Ltd. .. *Sup.* 7

Insulators, &c.—
Doulton & Co... .. .. .. *Sup.* 12
Edison & Swan United E. L. Co., Ltd... 11
International Trading Co... .. *Sup.* 13
Johnson & Phillips .. ..1 & 19
Price, Sons & Co. 20
Stiff & Sons .. ..
Telegraph Manufacturing Company *Sup.* 1

Iron and Steel—
Macfarlane & Co. .. ..
Sunderland Forge Company, Ltd. .. 7
Turner Bros. .. .. *Sup.* 15

Ladders, &c.—Heathman & Co. .. *Sup.* 10

Lamp Reflectors—
Edison & Swan U. E. L. Co., Ltd. .. 11

Lubricants—
A. L. Bayley .. .. *Sup.* 12
Engelbert & Co. .. .. .. *Sup.* 4
W. H. Willcox & Co. 3

Manufacturing Electricians—
A. & W. Hopkins .. .. .. *Sup.* 16
Johnson & Phillips .. ..1 & 19
Williamson & Joseph, Ltd. .. *Sup.* 7

Mica— PAGE
Baxters & Macdonald .. .. ..
Sanders, Wake & Co. .. .. *Sup.* 10
F. Wiggins & Sons 3

Motors—
Edison & Swan U. E. L. Co., Ltd. .. 11
L. Gardner & Sons .. .. .. *Sup.* 4
Johnson & Phillips .. ..1 & 19
J. H. Rigg 20

Oil Cans, Tanks, Lubricators, &c.—
Kingfisher Company .. .. ..
Wells & Co. .. ..

Patent Agent—J. G. Lorrain 19

Platinum—Derby & Co. .. .. *Sup.* 10
Edison & Swan United E. L. Co. Ltd... 11

Poles—
Johnson & Phillips (Wood & Iron).. ..1 & 19

Porcelain Appliances—
Bullers Limited 16
Dorman & Smith 9
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Co., Ltd... .. *Sup.* 8
J. Stiff & Sons .. ..
Williamson & Joseph, Ltd. .. *Sup.* 7

Porous Cells—J. Stiff & Sons .. ..

Pumping Engines—
G. E. Belliss & Co., Ltd. 4
F. Nell 20

Railway Signals—Saxby & Farmer .. 12

Safes—T. Skidmore & Son .. .. ..

Screws—
Davis & Timmins 22
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Company, Limited *Sup.* 8

Stampings—R. Jenkins .. .. *Sup.* 11

Steam Traps—
W. B. Haigh & Co. 7

Stoneware—
Doulton & Co... .. .. .. *Sup.* 12
J. Stiff & Sons .. ..

Switchboards—
Consolidated Telephone Cn. & M. Co. ..
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Company, Limited *Sup.* 8
Johnson & Phillips .. ..1 & 19
Williamson & Joseph, Ltd. .. *Sup.* 7

Telephones—
Consolidated Telephone Cn. & M. Co. ..
Edison & Swan United E. L. Co., Ltd... 11
General Electric Co., Ltd... .. *Sup.* 8
Gent & Co. .. .. *Sup.* 4
Western Electric Company .. *Sup.* 16

Tenders .. .. *Sup.* 12

Tools, &c.—H. Milnes .. ..

Tramway Supplies—
A. & J. M. Anderson .. .. *Sup.* 14

Transformers— PAGE
Consolidated Telephone Cn. & M. Co. ..
Edison & Swan United E. L. Co., Ltd... 11
General Electric Company, Limited *Sup.* 8

Turbines—
Gilbert Gilkes & Co. .. .. *Sup.* 4
S. Howes 20
F. Nell 20

Turners—
Bonella & Son.. 3

Typewriters—
The Yost Typewriter Co. .. .. *Sup.* 3

Vacuum Tubes—
Edison & Swan U. E. L. Co., Ltd. .. 11

Varnishes, &c.—
Fred. Crane Chemical Co .. ..

Ventilating—
G. E. Belliss & Co., Ltd. 4
Blackman Ventilating Company ..

Vulcanite—
Harburg I. R. Comb Company .. *Sup.* 9

Water Supplies—
Doulton & Co. .. .. .. *Sup.* 12

Wire (Covered)—
British Insulated Wire Company .. 6
Connolly Bros. .. ..
Edison & Swan U. E. L. Co., Ltd. .. 11
Fowler-Waring Cables Company ..
General Electric Co., Ltd... .. *Sup.* 8
W. T. Glover & Co. 2
W. T. Henley's Telegraph Works Co. ..
Johnson & Phillips .. ..1 & 19
London Electric Wire Company .. 5
W. Rickard .. .. *Sup.* 4
Telegraph Manufacturing Company *Sup.* 1
G. B. Unsworth .. .. .. *Sup.* 15
Williamson & Joseph, Ltd. .. *Sup.* 7

Wire (Uncovered)—
T. Bolton & Sons 15
Davis & Timmins 22
Phosphor Bronze Co. 8
Ramsden, Camm & Co. 19
F. Smith & Co. 3

Wire Covering Machinery—
Thos. Barraclough .. ..
Johnson & Phillips .. ..1 & 19

Wiring (Concentric)—
Andrews, J. D. F. & Co. 7
Mavor & Coulson .. ..
Sharp & Piper .. ..

Wood Casings, &c.—
Beecroft & Wightman 19
Edison & Swan U. E. L. Co., Ltd. .. 11
General Electric Co., Ltd... .. *Sup.* 8
J. F. & G. Harris .. .. .. *Sup.* 10
Viger Bros. 19

Miscellaneous Advertisements *relating to Situations, Articles for Sale and Wanted, &c., &c., appear on* **Sup. 9** *(middle of paper).*

LONDON ROAD IRON WORKS, GLASGOW.

TO STEAM USERS.

ENGINEERS AND BOILER MAKERS.

SAVES WATER COAL STEAM SAVES

IF YOUR ENGINES ARE NON-CONDENSING

IF YOUR ENGINES ARE OVERTAXED

IF YOUR BOILERS ARE HARD FIRED

THE THEISEN CONDENSER

CAN BE APPLIED ANYWHERE.

WILL MAKE EASY FIRING.

WILL GIVE POWER EASILY.

WILL SAVE MONEY EVERY HOUR.

SUGAR AND TEXTILE MACHINERY MAKERS.

WRITE FOR ILLUSTRATED CATALOGUE TO—

LONDON. **D. STEWART & CO., LTD.** GLASGOW.

122, CANNON STREET, E.C.

SILVER MEDAL, being the Highest and Only Award, Northumberland Agricultural Society, 1894.

THE "ROCKET" OIL ENGINE.

(Kaselowsky's Patents.)

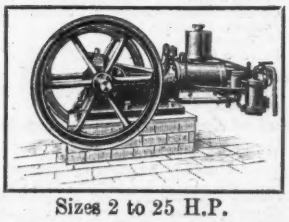
SPECIAL, HIGHEST, and ONLY AWARD, Glendale Agricultural Society, 1894.

Letter from
ROBERT SCOTT, Esq.,
Who uses a "Rocket" Oil Engine of 10 Horse-Power for Thrashing and Grinding.

Cobleheugh, Montrose, N.B., *May 8th*, 1897.

DEAR SIRS,—After an experience of six months with the "Rocket" Oil Engine, I have much pleasure in testifying most favourably as to its satisfactory working in every way. I find it most suitable in my own case for thrashing out and grinding grain, being most economical in oil consumption, especially with full load on, and running at a good speed. Since this engine was fixed up for me I have not required any assistance from the makers, as the whole management of it is very simple, and once set agoing does not require further attention than seeing to oil supply. I have had experience of steam power, and the dangers and risks of such. For farmers especially I can recommend the "Rocket" Oil Engine as giving a steady drive and a cheap motive power.—I am, yours faithfully,

(Signed) ROBERT SCOTT.



Sizes 2 to 25 H.P.

SPECIALLY BUILT FOR DRIVING DYNAMOS.

Letter from
THE WEARDALE & SHILDON DISTRICT WATER WORKS, CO.,
Who use two "Rocket" Oil Engines and two Treble Ram Pumps.

Engineer's Office, South Road, Bishop Auckland, *May 6th*, 1897.

GENTLEMEN,—The two 4-brake horse-power oil engines which you fixed for us last autumn at Etherley for the supply of Toft Hill have now been steadily working for five months without any hitch whatever. They do their work thoroughly, and are easily managed by one of our workmen whom we have placed in charge who had not had any previous experience in oil or gas engines. He gained sufficient experience in a fortnight's tuition from your workman, and, as you are aware, we have not had to call your men in since.—Yours faithfully,

(Signed) R. ASKWITH.
Resident Engineer.

WITH ALL THE LATEST IMPROVEMENTS.

Will be shown in motion at Stand No. 88, Royal Show, Manchester, June 23rd to 29th.

ROBERT STEPHENSON & CO. LTD., NEWCASTLE-ON-TYNE.

Locomotive and Marine Engineers and Shipbuilders, a433

EDISWAN

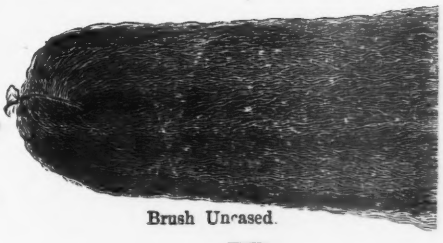
SPECIAL

DYNAMO AND MOTOR BRUSHES

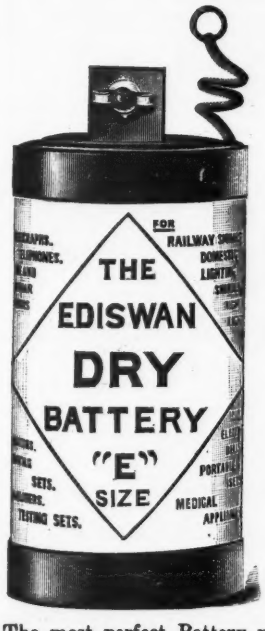
CHAPLIN'S PATENT.

Brush Cased.

Manufactured of 36 B.W.G. High Conductivity Copper Wire. The cost is no more than that of the common gauze brush.



Brush Uncased.

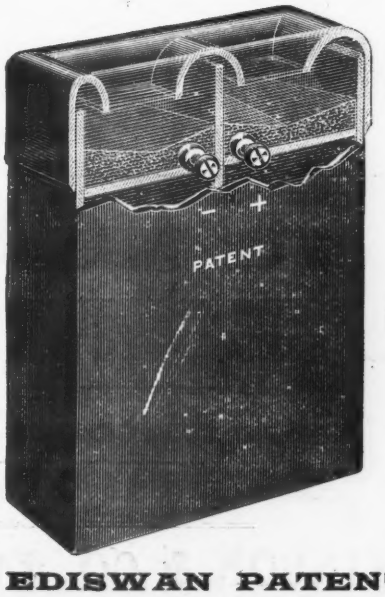


EDISWAN BATTERIES

The most perfect Battery manufactured, and can be used for Electric Bells, Telephones, Lighting Sets, Telegraphy, Exploders, Burglar Alarms, Fire Alarms, Motors, Night Lights, Testing Sets.

"EDISWAN" LECLANCHÉ CELLS,

For Electric Bells, Telephones, Lighting Sets, Telegraphy, Exploders, Burglar Alarms, Fire Alarms, Motors, Night Lights, Testing Sets.



Write - for - - Prices.

No delay. Large Stock. Immediate Delivery.

Head Offices, Warehouses and Showrooms—
Ediswan Buildings, Queen St., Cheapside, E C.

EDISWAN PATENT.
UNSPILLABLE BATTERY.

West End Offices and Showrooms—
53, Parliament Street.
Branches and Agencies throughout the world.

FARADAY & SON'S ELECTRIC FITTINGS

Dining Room Coronæ
Counter-poise Pendants
Spring Roller Pendants

Drawing Room Sconces
Porch and Loggia Lanterns
Adjustable Standards

2 & 3 BERNERS ST LONDON W

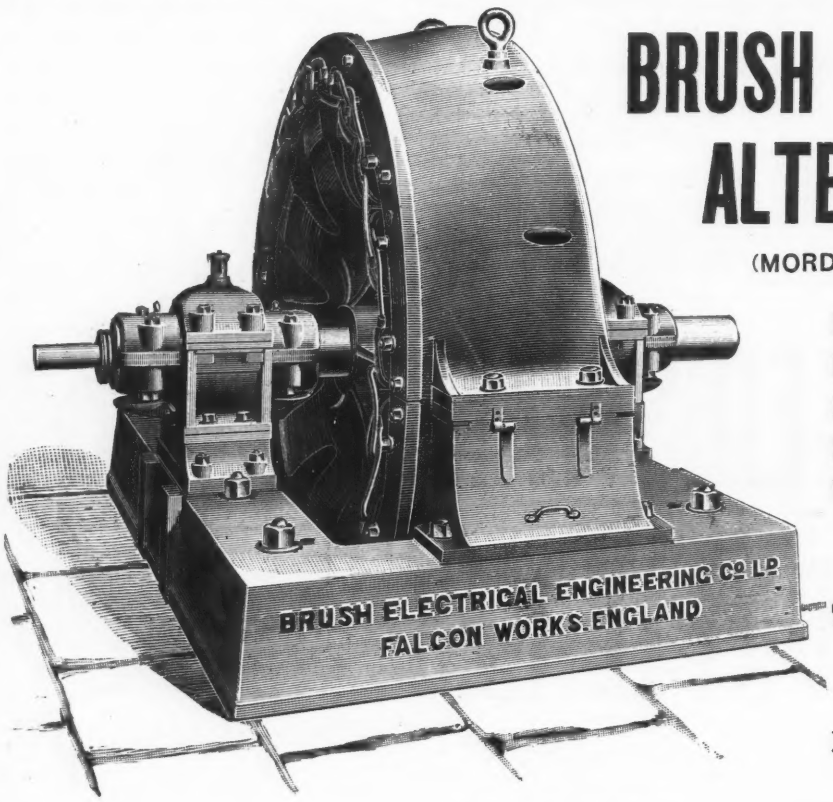
ELECTRICAL INTERLOCKING.

GOLD MEDAL, CRYSTAL PALACE, 1892.

The Board of Trade have again and again urged the necessity of combining the "Lock" and "Block" systems by actual connection between the Telegraph Instruments and Locking Levers, to effect "inter-dependent working." This great improvement, together with Supplementary Automatic Train Action, has been reliably accomplished and brought into practical use on several lines by Messrs. SAXBY & FARMER, under protection of various Patents granted or assigned to them. *Diploma of Honour (the Highest Award), Edinburgh, 1890.* For Particulars, Plans, and Estimates, apply to

SAXBY & FARMER, Ltd., Railway Signal Contractors, Canterbury Road, KILBURN, LONDON, N.W.

Manufacturers of Railway Signals, Cabins, Interlocking Levers, Block Instruments, and Signal Work of every description, Electrical and Mechanical. 443



BRUSH INDUCTOR ALTERNATOR

(MORDEY'S PATENT).

Durability Guaranteed.
No Moving Coil whatever.
High Efficiency.
Perfect Parallel Working.
Will stand short circuiting.

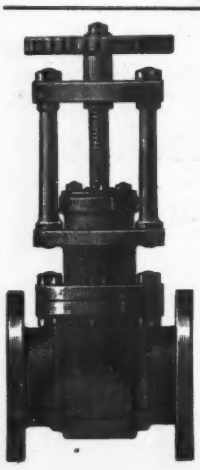
The leading machine on the continent.

Large order in hand for English stations.

SEND FOR LISTS TO

THE BRUSH ELECTRICAL ENGINEERING CO., Ltd.,

49, QUEEN VICTORIA STREET, LONDON, E.C. 4409



BOILER MOUNTINGS AND VALVES for all purposes.

Order "HOPKINSON'S own make."

CATALOGUES POST FREE.

J. HOPKINSON & CO., Ltd., Huddersfield,

Showroom & Depôt:—165, Queen Victoria St., LONDON, E.C.

Telegrams "Hopkinson, Huddersfield"; "Valvestem, London." 888

THE TELEGRAPH MANUFACTURING CO., Ltd.

ELECTRICAL AND TELEGRAPH ENGINEERS.

MANUFACTURERS and CONTRACTORS to the British ADMIRALTY, POST OFFICE, WAR OFFICE, all British RAILWAY Co.'s, ELECTRIC LIGHT Co.'s the NATIONAL TELEPHONE Co., COLONIAL GOVERNMENTS, MUNICIPALITIES, &c., &c.

For ELECTRIC LIGHT — Cables and Wires; Vulcanised Rubber, Lead Covered, Armoured; Mains, Concentrics, Flexible Cords.

TELEPHONE — Instruments Exchange Equipments; Cables, Wire Batteries, Insulators, Switchboards for Private Installations, Gutta Percha Wires.

TELEGRAPH — Postal Railway, Fire Alarm and Police Equipments Railway Signals and Blocks; Iron Poles, Insulators, Batteries, Cables, Gutta Percha wires

Works: HELSBY & 16, NEWINGTON, LIVERPOOL. Head Office: HELSBY, nr. Warrington, England.
Branch Offices: 11, Queen Victoria Street, LONDON, E.C.; 2, Parsonage, MANCHESTER; and 30, Hope Street, GLASGOW.

5161

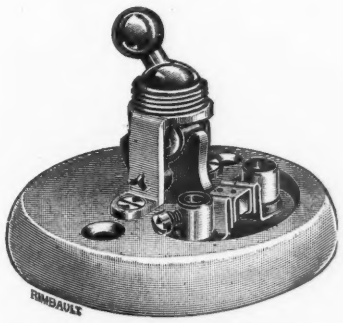
Telegraphic Addresses:
"VERITY, BIRMINGHAM."
"VERITY, LONDON."

VERITYS, LTD.,

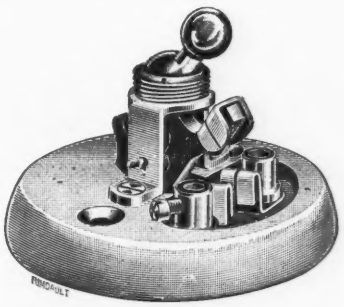
TRADE MARK

ELECTRICAL FITTINGS AND ACCESSORIES MANUFACTURERS,

PLUME WORKS, ASTON, BIRMINGHAM.
31, KING STREET, COVENT GARDEN, LONDON.



The I.B. Tumbler "On."



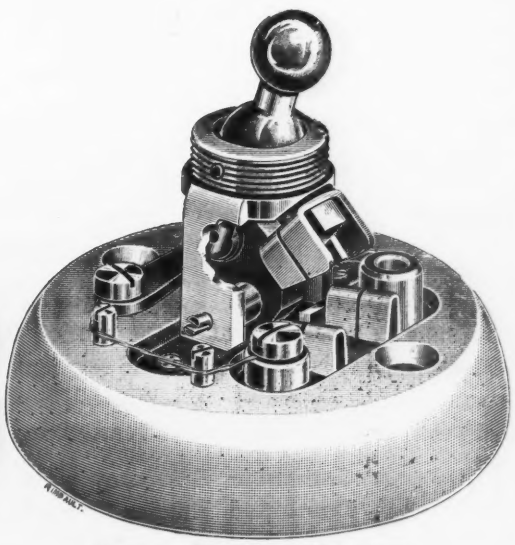
"Off."

THE I.B.

(INCREASED BREAK)

TUMBLERS

(PATENTED).



10 amp. Tumbler with Fuse.

WRITE FOR PARTICULARS AND PRICES.

5225—6

THE ELECTRIC CONSTRUCTION COMPANY, Ltd.,

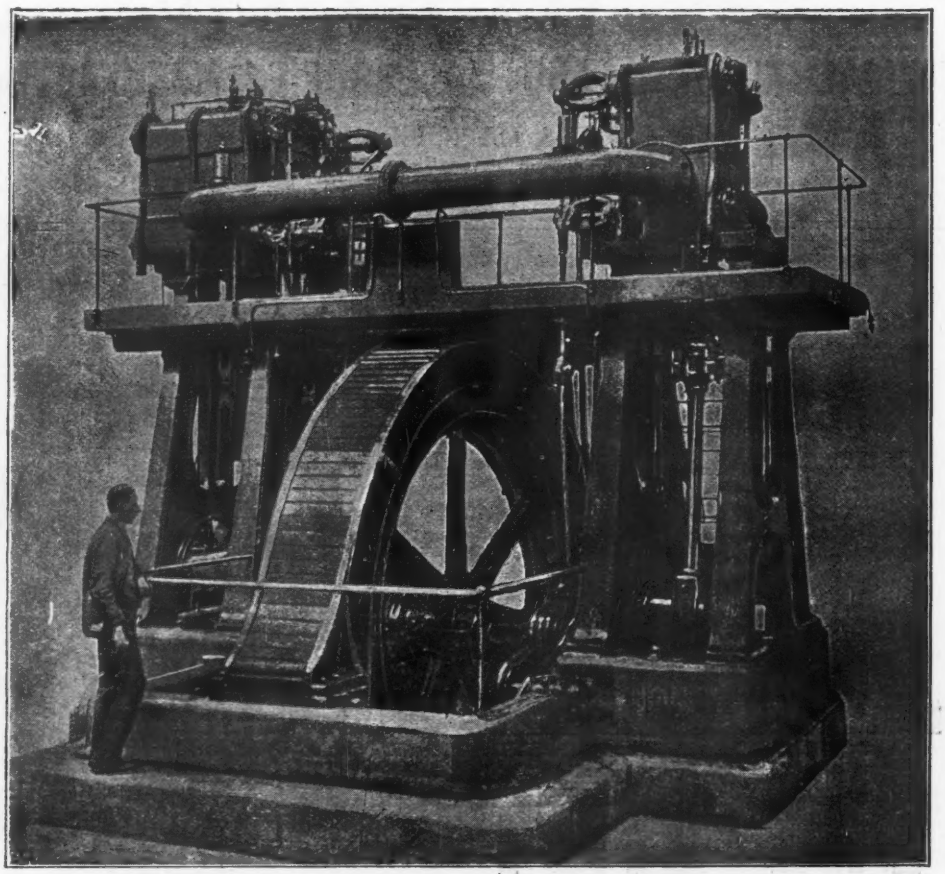
Telegraphic Address:
"ELECTRIC, WOLVERHAMPTON."
Telephone No. 7,075.

WOLVERHAMPTON,

MANUFACTURERS OF EVERY DESCRIPTION OF ELECTRIC POWER PLANT, ARC LAMPS, SWITCHES, &c.,

Contractors to H.M. War Office, Admiralty, &c.

HALIFAX CORPORATION ELECTRIC LIGHT STATION.



350 KILOWATT FLY-WHEEL ALTERNATOR.

The Alternator illustrated above has the fly-wheel mounted direct on the engine shaft, the field magnets being fixed to the rim of the wheel and excited by means of a single coil. The Armature Core is composed of 38 segments, each having a coil wound through slots. The engine manufactured by Pollit and Wigzell, Sowerby Bridge, is of the vertical compound condensing type with special Corliss valve gear, giving 600 I.H.P. at 137 revolutions.

Combined Efficiency at Full Load ... ... 82 per cent.
Combined Efficiency at Half Load ... ... 72 per cent.

Periodicity 87 per Second.

London Office: DASHWOOD HOUSE, 9, NEW BROAD ST., E.C.

Telegraphic Address:—"CONCORDANCE, LONDON." TELEPHONE No. 11,781.

STERLING MERIT - IS THE - KEYNOTE - OF - SUCCESS.

This explains why the . . . .

No. 4 YŌST TYPEWRITER

has so easily attained a world-wide fame. Being constructed of the finest materials, speedy, light, compact, and economical in working, and having an Ink Pad which is guaranteed for six months, it is indeed

The ideal Writing Machine.

ADOPTED BY ROYALTY AND ARISTOCRACY AND MORE THAN **35,000** OTHER USERS.

Full Particulars on Application to

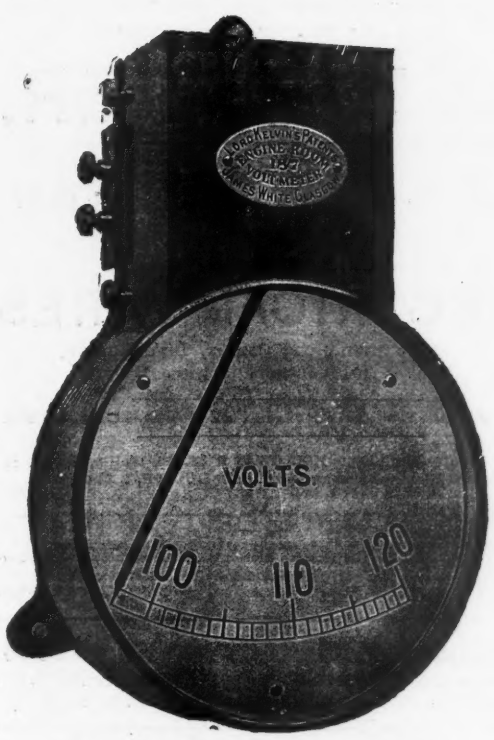
THE YŌST TYPEWRITER CO., Ltd.,

50, HOLBORN VIADUCT, LONDON, E.C.

LIVERPOOL: 22a, North John Street.
GLASGOW: 112, St. Vincent Street.
MANCHESTER: 3, Deansgate.
BIRMINGHAM: 73, Temple Row.
DUBLIN: 17, Nassau Street.
LEEDS: 15, Briggate.
CARDIFF: 77, St. Mary Street.
NEWCASTLE-ON-TYNE: 50, Dean Street.
BELFAST: 13, Rosemary Street.
MARSEILLES: 25, Rue Paradis.
PARIS: 36, Boulevard des Italiens.
LYONS: 2, Rue Lafont.
EDINBURGH: 12, North St. Andrew Street,

LORD KELVIN'S

ELECTRIC INSTRUMENTS.



SMALL DIAL CENTRAL STATION VOLTMETER.
Scale, approximately ⅛ full size.

ELECTROSTATIC VOLTMETERS

Ranges, 20 to 10,000 Volts.

RECORDING VOLTMETERS AND AMPEREMETERS.

AMPERE GAUGES,
SWITCHBOARD WATTMETERS,
ELECTRICITY SUPPLY METERS,
PORTABLE TESTING SETS,
&c., &c., &c.

Write for New Price Sheets to—

JAMES WHITE,

18, CAMBRIDGE STREET,

GLASGOW.

2042

Telegraphic Address: "MUIRHEAD, LONDON."

MUIRHEAD & Co.,

ELECTRICAL ENGINEERS.

MANUFACTURERS OF THE WELL KNOWN

"WESTMINSTER" DYNAMOS

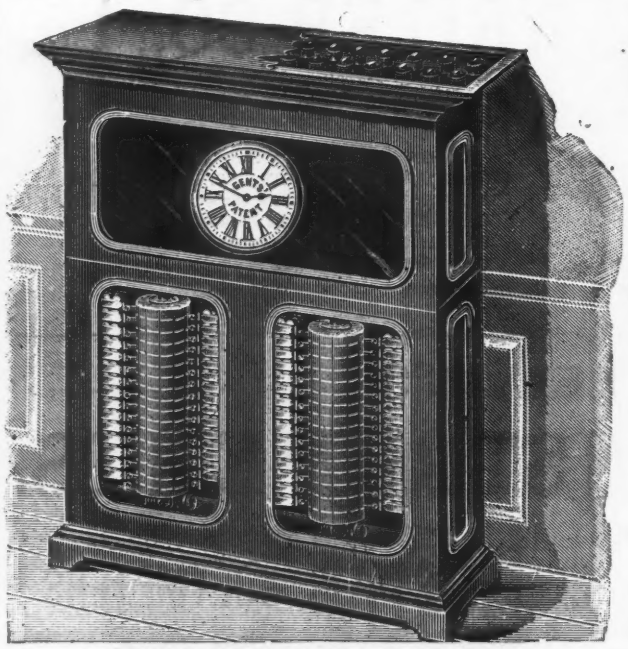
HOPKINSON'S PATENT AUTOMATIC

BATTERY REGULATING SWITCHES.

STANDARD CELLS.—Dr. Muirhead's Patent Portable Form, with Certificate of Value.

NOTICE.—Removal of Works to ELMER'S END, KENT, adjoining S.E. Railway Station.

All Letters to be addressed to our City Office, 54, OLD BROAD STREET, E.C. a373



GENT & CO.'S

ELECTRIC

WATCHMAN'S CLOCKS,

Fitted in nearly all the Large Asylums throughout the Country and in many large factories, &c., including

RUDGE-WHITWORTH CYCLE WORKS (Three Clocks),
HUDSON'S SOAP WORKS,
BIRD'S CUSTARD POWDER WORKS,
&c., &c., &c.

Illustration shows one of a pair of clocks at Lancashire County Asylum.

ADDRESS:—

FARADAY WORKS,

LEICESTER. a126

WEBB & SON,

TANNERS, CURRIERS, FELLMONGERS, GLOVE AND GAITER LEATHER DRESSERS, LEATHER AND WOOL MERCHANTS.

LEATHER MACHINE BANDS.

FIRE BUCKETS AND HOSE.

12 FIRST-CLASS MEDALS AWARDED.

Manufacturers of

Combs Tannery, Stowmarket.

Price Lists and Terms on Application. a327

WILLIAM RICKARD,

DERBY.

ELECTRICAL WIRES

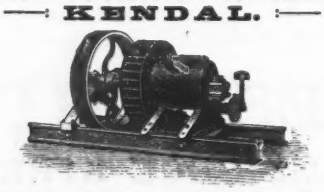
INSULATED WITH SILK, COTTON, INDIA-RUBBER, GUTTA-PERCHA, &c., &c.

FLEXIBLE CORDS A SPECIALITY

London Agents—Stock kept—HOLLOWAY & CO., 92, Watling Street, E.
Bradford Agents—Stock kept—ARTHUR HUDSON, 5, Cheapside. 509

GILBERT GILKES & CO., LTD.,

KENDAL.



VORTEX TURBINES. GIRARD TURBINES. PELTON WHEELS.

TURBINES OF ALL CLASSES.

WRITE FOR PARTICULARS. 503

THE PHŒNIX DYNAMO MANUFACTURING CO.,

Makers of all kinds of Electrical Plant, Hubert Street Works, Leeds Road, Bradford

See our Page Advertisement First Friday in each month.

L. GARDNER & SONS, MANCHESTER.

DYNAMOS, MOTORS GAS ENGINES.

See Page Advertisement Third Friday of each mon h.

ENGELBERT & Co., London,

LUBRICANT MANUFACTURERS,

Vide full advertisement in last issue, also next issue.

EXTENSION OF AN EXISTING MANUFACTURING CONCERN, WITH WELL-ESTABLISHED BUSINESS, PAYING LARGE DIVIDENDS. NO UNDERWRITING. NO PROMOTION MONEY.

The Subscription List will Open on Monday, June 28th, at 10 a.m., and Close on or before Thursday, July 1st, 1897.

THE BRITISH INSULATED WIRE CO., LTD.

(Incorporated under the Companies Acts).

Authorised Share Capital:—40,000 Six Per Cent. Cumulative Preference Shares of £5 each, £200,000; 40,000 Ordinary Shares of £5 each, £200,000.

The Preference Shares confer the right to a fixed cumulative Preferential Dividend at the rate of £6 per cent. per annum, and the right to repayment of Capital at par in priority to the Ordinary Shares, but do not confer on the holders the right to attend or vote, either in person or by proxy, at any General Meeting, unless the Dividend upon the said Shares or any of them is one month in arrear, or the meeting is convened for increasing or reducing the capital, or winding up, or sanctioning a sale of the undertaking, or altering the regulations of the company, or where the proposition to be submitted to the Meeting directly affects the rights and privileges of the Preference Shareholders.

Issue of 20,000 6 Per Cent. Cumulative Preference Shares of £5 each, and 40,000 Ordinary Shares of £5 each, of which there are now offered for Subscription

14,470 Preference Shares, £72,350, and 10,375 Ordinary Shares, £51,875,

Leaving £100,000 of Preference Shares for future issue, if required, the balance of the present issue being taken by the Shareholders in the Vendor Company, the British Insulated Wire Co. (1890) in full payment of purchase money. The Shares now offered will be payable 10s. on application, 20s. on Allotment, and the balance in calls of not more than 25s. each, at intervals of not less than two months.

Directors.

W. MARRINER BRIGG, Hawkstone, Keighley (*Chairman*).
EDMUND K. MUSPRATT, J.P., Seaforth Hall, near Liverpool.
JAMES B. ATHERTON, Manhattan, Rainhill.
S. Z. DE FERRANTI, M.I.E.E., Broomhurst, Werneth, Oldham.
JOHN E. PEARSON, 63, Catherine Street, Liverpool.
THOMAS SNAPE, J.P., The Gables, Croxteth Road, Liverpool.

Bankers.

PARR'S BANK, LIMITED, Prescot, Liverpool, St. Helens, and at all their branches, and at their London Office, Bartholomew Lane, E.C.

Solicitors.—F. J. LESLIE & CO., 15, Union Court, Castle Street, Liverpool.

Auditors.—CHALMERS, WADE & CO., Chartered Accountants, 5, Fenwick Street, Liverpool, and 18, Queen Victoria Street, London, E.C.

Brokers.

LIVERPOOL—ASHTON, TOD & NOBLE, 7, Tithebarn Street.
LONDON—JAMES CAPEL & CO., 31, Throgmorton Street, E.C.

Secretary.—EDWARD TRACEY.

Registered Offices and Works.

PRESCOT, Lancashire. LONDON OFFICE—11, Charing Cross Road, W.C.

Telegraphic Addresses.

"Insulator," Prescot. "Airlike," London.

PROSPECTUS.

THIS COMPANY has been formed to acquire and take over as a going concern as from April 27th, 1897, the entire business, property, and assets of the BRITISH INSULATED WIRE COMPANY, LIMITED, established in 1890 at Prescot, eight miles from Liverpool, as manufacturers of cables for electric lighting transmission of power, telegraph, and telephone purposes, and of house wires, and other electrical appliances. That company is for convenience hereinafter referred to as the Old Company.

The object is to bring in additional working capital, and so enable the very large and still rapidly increasing volume of business to be adequately dealt with. Owing to the constitution of the Old Company, it was found impracticable to attain this object without the formation of a new company.

WORKS.—The Works are adjacent to Prescot Station on the London and North-Western Railway, with which they are connected by a Private Siding. The land held by the company comprises about 10 acres, and the various departments and shops have been carefully arranged in proper sequence so as to facilitate the process of manufacture.

MANUFACTURES, PATENTS, AND BUSINESS OF COMPANY.—The old company was formed to acquire and work certain patents for the production of Paper Insulated Electric Wires and Cables, and has been exceedingly successful.

It has since become possessed of numerous further Inventions and Patents of value, including improvements on the original patents, and also a set of patents for a new and successful system of house wiring. It now owns and will assign to this company *Fifty-five British and Foreign Patents.*

In assessing the value of the Company's Patents (given below) nothing has been added for many valuable Patents recently acquired, and from the cost of the Patents large sums have been written off for depreciation.

The Company's business has grown by rapid strides, until now it *stands in the first rank of Electric Cable Manufacturers* both in the extent of its products and in the reputation they bear.

The Cables made by the Company are working satisfactorily at the highest pressure yet used for Electric Lighting, and have even been tested up to the *extraordinarily high pressure of* 95,000 *volts*, with complete and uniform success.

WORK NOW IN HAND.—*The Company took over from the Old Company orders exceeding £200,000 in value from the Home and Colonial Governments, Municipal Authorities, and Electric Supply Companies, and has now on its books further large orders since received.*

MANAGEMENT.—The Chairman and the whole of the Board have been Directors of the Old Company, and their services, and those of the staff, will be continued with this Company, *so that the business will be carried on without break or interruption* under the management which has hitherto produced such satisfactory results.

PROPERTY AND ASSETS.—The assets purchased by the company are as follows:—

Leasehold property at Prescot and buildings thereon, with machinery and plant, valued on December 31st, 1896, by Messrs. Wheatley Kirk, Price & Goulty, of London and Manchester at	£88,118	10	9
Additions since that date	3,677	0	3
Stock of copper, taken at cost price	31,005	15	0
Cables and wires completed or in course of manufacture on April 27th, 1897	18,675	1	10
Other stock in trade..	10,588	3	3
Book debts, cash, and bills (less estimated discounts) of the old company, as per Messrs. Chalmers, Wade and Co.'s certificate	57,227	6	6
Patents as per balance sheet on December 31st, 1896 (assessed as above)	52,876	9	5
Plant for public electric lighting, and costs in connection with provisional orders, as per Board of Trade accounts, December 31st, 1895	10,555	1	2
Additions since that date	425	12	9
Total assets (exclusive of goodwill)	£223,149	0	11

The profits made since April 27th, 1897, will also belong to the new Company. The liabilities taken over from the old Company are the Debenture issue of £47,400, the interest and dividends payable to Debenture Holders and Shareholders of the old Company to April 27th, 1897, estimated at £9,000, and the ordinary business debits, estimated not to exceed £54,000.

PROFITS.—As an evidence of the earning capacity of the business, it will be seen from the following certificate that *for the year* 1896 the *net profits amounted to £36,095, and for the period (less than four months) from January 1st to April 27th,* 1897, *the net profits have been £16,890, showing an increase at the rate of more than 45 per cent. per annum over* 1896.

5, FENWICK STREET, LIVERPOOL, *June 19th,* 1897.

"*To the Directors of* THE BRITISH INSULATED WIRE CO., LIMITED, PRESCOT.

We have examined the Books of the British Insulated Wire Co., Limited, Prescot, for the period from 1st January, 1894 to 27th April, 1897, and certify that after providing for Bad and Doubtful Debts, Directors' Fees, &c., the Profits for the period have amounted to £91,912 11s. 10d., showing an average of £27,679 per annum. This is subject to the necessary allowances for Depreciation of Plant, Machinery, and Patents, and for Interest on Debentures.

The *Profits* for 1896 were.....£36,095 12 3 per annum.
Do. from 1st January to 27th April, 1897, amounted to £16,890 9s. 11d. being at the rate of.....£52,692 0 0 do.

CHALMERS, WADE & Co., *Chartered Accountants.*"

It will thus be seen that the average profits are more than three times the amount required to pay the Debenture Interest and Preference Dividend.

If the actual profits of last year be taken as a basis, and assuming the very improbable result that the increase of the Working Capital should produce no increase of profits, the following estimate may reasonably be made:—

Net Profits of Business.....		£36,095
Deducting Interest on £47,400 Debentures at 5 per cent...£2,370		
and Dividend on Preference Shares at 6 per cent.....	6,000	
		8,370
There would remain a balance of.....		£27,725

available for Depreciation, Reserve Fund, and a large Dividend on the £200,000 Ordinary Shares.

The purchase price has been fixed by the Old Company, who are the Vendors and is represented by 5,530 Preference Shares and 29,625 Ordinary Shares of the present issue (amounting to £175,775 in the aggregate). Such Shares will be issued and dealt with as provided by the agreement of sale hereinafter mentioned. The New Company is taking over the business as a going concern, and as incidental thereto will undertake the debts, liabilities, and obligations of the Old Company (estimated above), and will also pay the costs and expenses of and incidental to the winding up of the Old Company.

The following Contracts have been entered into:—(1st. An agreement dated the 5th March, 1897, between James Basnett Atherton, the Old Company, and Edward Tracey on behalf of this Company (for the acquisition of the Founders' Shares in the Old Company. (2nd.) An agreement dated the 26th April, 1897, between the Old Company, David Lockhart Chalmers and Edward Tracey (Liquidators), and this Company (being the agreement for sale and reconstruction).

There are numerous trade and other Contracts relating to the conduct of the Company's business, which cannot conveniently be specified here, and to avoid all questions as to what is required to be stated under the provisions of Section 38 of the Companies' Act, 1867, applicants must be deemed to have had notice of these Contracts, and to have waived all right to any particulars thereof, whether under that Section or otherwise.

None of the Capital will be underwritten, and no promotion money or intermediate profit of any kind will be paid.

An Official Quotation of the Preference and Ordinary Shares on the London and Liverpool Stock Exchanges will be applied for. Both the Preference and Ordinary Shares of the Old Company were officially quoted at a premium on the Liverpool Stock Exchange.

Copies of the Memorandum and Articles of Association, and the Contracts, Valuations, and Certificates above referred to, may be seen at the Office of the Solicitors to the Company.

Applications for Shares should be made on the accompanying form or on the form appended to the newspaper advertisement, and forwarded to the Bankers of the Company, together with the amount payable on application.

Where no Allotment is made the deposit will be returned in full, and where the number of Shares allotted is less than applied for the surplus will be credited to the payment due on Allotment.

Prospectuses and Forms of Application for Shares can be had from the Bankers, Brokers, Solicitors and Auditors of the Company, and at the Company's Offices in Prescot and London.

PRESCOT, *June 23rd,* 1897.

PREFERENCE SHARES.

THE BRITISH INSULATED WIRE COMPANY (Limited).—Capital £400,000, divided into 40,000 Six per cent. Cumulative Preference Shares of £5 each, and 40,000 Ordinary Shares of £5 each.

FORM OF APPLICATION FOR SIX PER CENT. PREFERENCE SHARES.

To the Directors of the British Insulated Wire Company (Limited).

Gentlemen,—Having paid to the Bankers of your Company the sum of £ , being a deposit of 10s. per share on application for Six per cent. Cumulative Preference Shares of £5 each in such Company, I hereby request that you will allot me that number, and I agree to accept such shares, or any smaller number you may allot to me, upon the terms and conditions of the Prospectus and the Memorandum and Articles of Association of the Company. And I request you to place my name on the Register of Shareholders in respect of the shares which you may so allot to me, and I agree to pay the balance as required, in terms of the said Prospectus. And I agree with the Company, as Trustee for the Directors and other persons liable, to waive any fuller compliance with Section 38 of the Companies Act, 1867, than that contained in such Prospectus.

Signature_____
Name (in full)_____
Address (in full) _____
Occupation _____
Date of Application _____

ORDINARY SHARES.

THE BRITISH INSULATED WIRE COMPANY (Limited).—Capital £400,000, Divided into 40,000 Preference Shares of £5 each, and 40,000 Ordinary Shares of £5 each.

FORM OF APPLICATION FOR ORDINARY SHARES.

To the Directors of the British Insulated Wire Company (Limited).

Gentlemen,—Having paid to the Bankers of your Company the sum of £ , being a deposit of 10s. per share on application for Ordinary Shares of £5 each in such Company, I hereby request that you will allot to me that number, and I agree to accept such shares, or any smaller number you may allot to me, upon the terms and conditions of the Prospectus and the Memorandum and Articles of Association of the Company. And I request you to place my name on the Register of Shareholders in respect of the shares which you may so allot to me, and I agree to pay the balance as required, in terms of the said Prospectus. And I agree with the Company, as Trustee for the Directors and other persons liable, to waive any fuller compliance with Section 38 of the Companies Act, 1867, than that contained in such Prospectus.

Signature_____
Name (in full) _____
Address (in full)_____
Occupation _____
Date of Application _____

BROCKIE-PELL ARC LAMP

(LIMITED),

97, Queen Victoria Street, LONDON, E.C.

Telegrams: "Illuminers, London." Telephone No. "Bank 294.

OWNERS OF THE PATENTS AND SOLE MAKERS

of the well-known

BROCKIE-PELL ARC LAMP

as used by

H.M. GOVERNMENT in numerous Departments (over 1,000 lamps).

COLONIAL and FOREIGN GOVERNMENTS. | UPWARDS of 20 RAILWAYS.

OVER 40 CORPORATIONS and VESTRIES. | OVER 50 ELECTRICITY SUPPLY STATIONS

And by Docks, Harbours Mines, Factories, Shops, Theatres, Exhibitions, &c., &c., all over the world.

NOTICE.

On and after 1st June, 1897, all lamps issued by this Company will bear our Trade Mark

"BROCHIPEL"

The CAMBRIDGE ELECTRIC SUPPLY CO., Ltd.,
Thompson's Lane, Cambridge.
May 5th, 1897.

Messrs. MELDRUM BROS., MANCHESTER.

. . YOUR FURNACES . .

Dear Sirs,

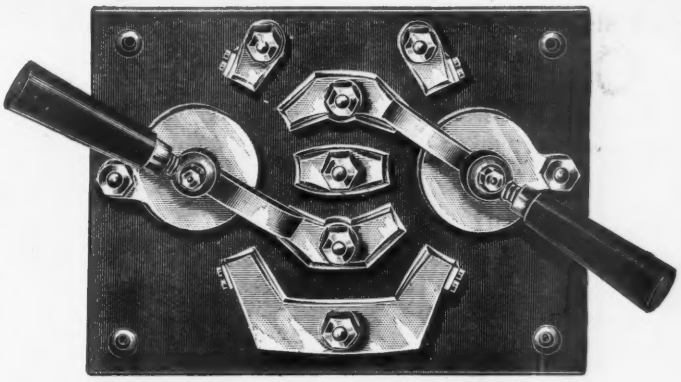
At the end of the month's trial, April 30th, you will be glad to hear that your furnace has fulfilled the guarantee: the amount per unit generated in coal has been reduced by 17½ per cent. and per unit sold 30 per cent. The absence of smoke is very marked, excepting a slight amount when the boiler has been forced hard: we have on several occasions obtained an evaporation of over 8,000 lbs. per hour (boiler being two-flue Lancs., 30 ft. by 7 ft. 6 in.). There is little doubt that the Board at their next meeting will decide to have these furnaces to the two remaining boilers.

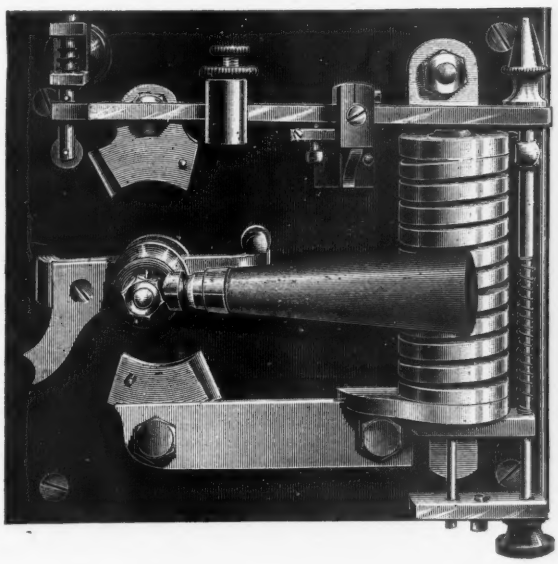
(Signed) JOHN H. BARKER.

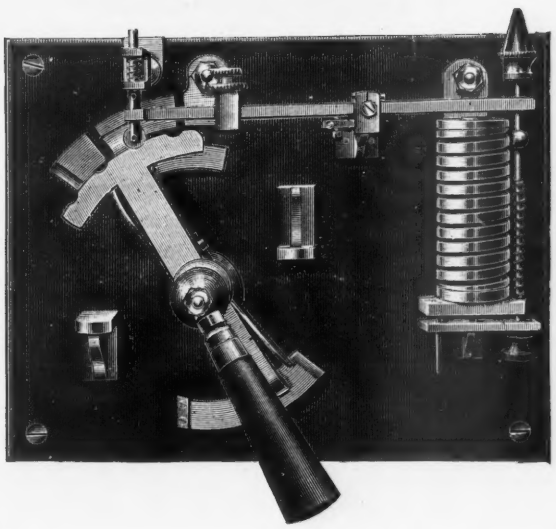
NOTE.—Since the above letter was written we have received the order for the two remaining boilers.

MELDRUM BROS., MANCHESTER.

8610







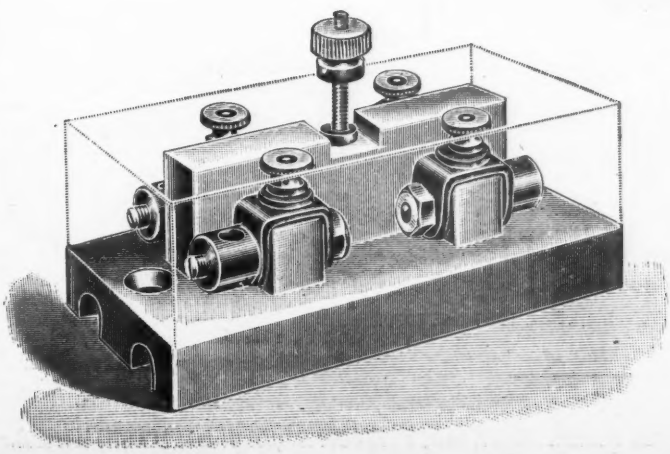
FOR PRICES AND PARTICULARS

APPLY TO THE

ACTUAL MANUFACTURERS,

WILLIAMSON & JOSEPH, Ltd.,

92, QUEEN VICTORIA STREET,
LONDON, E.C.;
And Tower Bridge Electrical Works.



Resistances,
Office Fittings,
Brackets,
Engines,
Reflectors,
Testing Instruments,
Switches,
Opal Shades,
Night Light Sets.

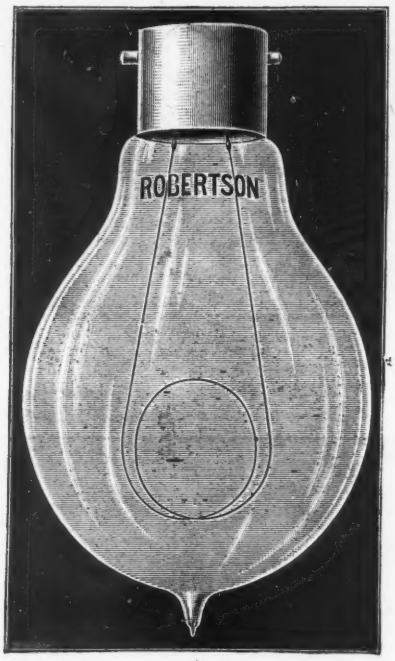
Lampholders,
Ammeters,
Motors,
Pushes and Pulls,
Switchboards.

Standards,
Tubing (Interior Conduit),
Insulators,
Lifts,
Lightning Conductors and Arresters.

Leclanché Cells,
Electricity Meters,
Accumulators,
Dynamos.

Telephones,
Heating Apparatus,
Eclipse Fuses.

Wall Plugs,
Arc Lamps,
You should



"ROBERTSON"
English Made
Incandescent Lamps.

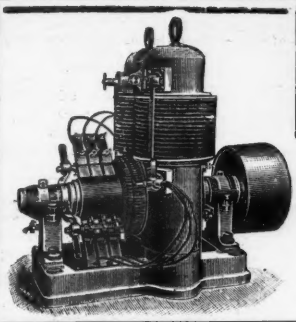
THE
GENERAL ELECTRIC
COMPANY, LIMITED.

HEAD OFFICES & SHOWROOMS:—
69, 71 & 88, Queen Victoria Street, LONDON.

WORKS:—Peel Works, Adelphi, SALFORD;
Brook Green, Hammersmith, LONDON.

Telegrams:—"ELECTRICITY, LONDON." Telephone Nos. 1887 and 1917.

CALL and INSPECT our MAGNIFICENT SHOWROOMS at 88, QUEEN VICTORIA STREET, where we EXHIBIT £20,000 worth of ARTISTIC FITTINGS.



"CASTLE" SLOW SPEED. HIGH EFFICIENCY.

J. H. HOLMES & CO., NEWCASTLE-ON-TYNE, AND 17, SOHO SQUARE, W.

DYNAMOS

2662

THE ELECTRICAL REVIEW.

PUBLISHED EVERY FRIDAY, PRICE 4d.

Office: 22, PATERNOSTER ROW LONDON.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

NOTICE TO ADVERTISERS.

The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements, or Alterations to existing ones, Wednesday 2 p.m.

Small Announcements for middle pages, Thursday 2 p.m.

TELEPHONE No. 15,077 Telegrams: "INDICES," LONDON.

WHEATLEY KIRK, PRICE & GOULTY

(ESTABLISHED 1866),

Electrical Auctioneers, Valuers,

AND ARBITRATORS.

Average Annual Valuations exceed £1,500,000 Sterling.

49, QUEEN VICTORIA STREET, LONDON E.C.

a2391

CHEAP PREPAID ADVERTISEMENTS,

Relating to *Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of* ONE PENNY *Per Word* (*minimum* 1s.).

Three consecutive Insertions for the Price for Two.

*** This Scale does not apply to Trade Advertisements, terms for which can be had on application.

SITUATIONS VACANT.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Original Testimonials should never be sent.

ELECTRICIAN.—Wanted, a first-class Man accustomed to undertake every class of electrical work, to take charge of the work orders at a retail electrical shop. Married man preferred.—1,092, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1092

PREMIUM PUPILS.—Large electrical manufacturing works, near London, have several vacancies.—Address a753, ELECTRICAL REVIEW, 22, Paternoster Row, London. a753

REPRESENTATIVE WANTED.—Foreign firm of incandescent lamps with very large production, whose make is well introduced in the English Market, requires a responsible firm in London to act as their sole agent for the United Kingdom. Stocks will be kept to supply current demand. Very liberal terms.—Address, stating full particulars with references, "J. M.," 5,335, care of Rudolf Mosse, Berlin, S.W. 1006

WANTED.—Two Armature Winders. Liberal wages paid to competent men; constant employment; Manchester district.—1,084, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1084

WANTED.—Competent Draughtsman with experience in designing of electrical machinery, both high tension and low tension. Manchester district.—Apply, 1,085, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1085

WANTED. — First-class Draughtsman accustomed to the designing of dynamos, motors, and switchboards.—Address 1,097, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1097

WANTED.—Several First-class Junior Draughtsmen, well up in dynamo and switchboard work.—Apply, stating age and full particulars, in confidence, to General Manager, P. R. JACKSON AND CO., LTD., Salford Rolling Mills, Manchester. 1098

WORKING FOREMAN Wanted for Small Works, experienced in vulcanised cables, silk and cotton covered wires, braiding, &c. Permanent situation for good steady man. State wage and experience.—Apply, a1,052, ELECTRICAL REVIEW, 22, Paternoster Row, London. a1052

VULCANITE.

HARBURG INDIA-RUBBER C. COMPANY.

London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.

EBONITE.

1710

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

A. I.E.E., 8 years' experience dynamo design, installations, estimating, office work, seeks re-engagement.—a1,049, ELECTRICAL REVIEW, 22, Paternoster Row, London. a1049

ASSISTANT Electrician wants situation, four years' experience; own tools.—1,058, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1058

ENGINEER (26) requires situation, charge of private plant preferred. Good experience with leading firms, mechanical and electrical, good draughtsman and mechanic.—Address 1,067, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1067

ELECTRICAL ENGINEER, nine years' experience, speaks Spanish, requires situation abroad or at home.—Apply "E. E.," care of Mrs. Ritchie, 110, Hill Street, Glasgow. 1080

ELECTRICAL ENGINEER, 14 years' practical work in installations, desires berth, home or abroad. Speaks French.—DE SOLOME, 3, Prospect Place, Harrogate. a1044

ELECTRICAL ENGINEER (29), requires appointment at home or abroad, as manager, engineer, agent, or other responsible position. Workshop and outdoor experience.—Address ELECTRICAL, Willings, 162, Piccadilly. a1038

ELECTRICIAN requires Situation to take charge of private electric plant; own repairs.—Apply, "E. P.," Whitchurch, Oxon, Reading. 1090

FOREMAN (Working), having many years' experience in lighting, telephone, and bell work; also in fixing of engines, dynamos, accumulators, &c., seeks similar position. Excellent testimonials.—1,100, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1100

SITUATION Wanted, has been six years in charge of electric lighting plant, bells, heating apparatus, ice making and pumping machinery, doing all repairs, &c.—"F. M.," 295, Upper Street, Islington. 1070

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

Where Advertisements are to be answered to a given number, letter or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ACCUMULATOR RECHARGING.—Peto & Radford, Ltd., having increased their storage battery plant, are now prepared to make additional contracts for recharging accumulators of all sizes. Power available night and day. Telephone No. 6,994.—PETO & RADFORD, LTD., 57B, Hatton Garden, London, E.C. 1089

ACCUMULATOR Charging.—C. H. Cathcart & Co., having plant specially adapted for this purpoee, charge cells of all sizes promptly, thoroughly, and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 65,266). 7345

COMPOUND Dynamo, 60 amperes × 110 volts, also compound dynamo, 24 amperes × 50 volts, sell cheap.—BROOK, Electric Light Station, Brighouse. 1060

[*Continued on next page.*]

ELECTRO-PLATING and Electrical Business.—Practical man wanted at once as Partner, with small capital; excellent prospects.—Address a1,039, ELECTRICAL REVIEW, 22, Paternoster Row, London. a1039

FOR SALE.—25 "Jandus" continuous current arc lamps, 6 amperes, 120 volts; six "Jandus" continuous current arc lamps, 6 amperes, 230 volts. All complete with globes, quite new, never been unpacked.—For particulars, apply to D. SELBY BIGGE AND CO., Newcastle-on-Tyne. 1074

PLATINIUM in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6522

SECONDHAND Plating Dynamo wanted, from 5 to 10 volts, any amperes.—Write 1,064, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1064

STEAM ENGINE and Dynamo or Alternator wanted, about 200 kilowatts, immediate delivery. — All particulars and prices to 1,063, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1063

WANTED.—Old scrap cable, wire, &c.; any quantity bought. —EDEY & Co. 29, Ludgate Hill. 1092

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 256, Ferndale Road, Brixton a1008

WANTED, in good condition, second-hand "Silvertown" or or other testing set. Particulars and lowest price by letter to "ENGINEER," 37, Bellefields Road, Brixton, S.W. a1036

WANTED.—Prices per cwt. for good quality Bitumen, raw and manufactured.—Address, Box 1,600, Sell's Offices, Fleet Street, London. 1087

a343

MICA

For Dynamos, and all Electrical Purposes. Large stocks of all qualities on hand. Speciality, Mica for Commutators, cut to any shape, and of equal and uniform thickness.

SANDERS, WAKE & CO.,

Office—23 Great St. Helens, LONDON, E.C., Contractors to H.M. Government.

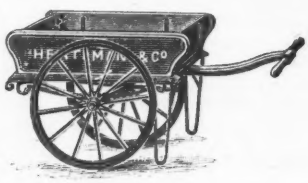
Telegrams—"Awake, London." Telephone—2,266, Avenue. a220

ELECTRIC WIRE CASINGS,
BLOCKS, CLEATS, BOARDS for SWITCHES IN STOCK & MADE TO ANY DESIGN.
ACCUMULATOR CASES, BATTERY BOXES, &c.
MADE TO ORDER ON SHORTEST NOTICE.

J. F. & G. HARRIS,

TIMBER MERCHANTS & MOULDING MANUFACTURERS.

YARDS and MILLS { 82, WILSON STREET, FINSBURY, E.C. / 42, ORANGE ST., Gravel Lane, SOUTHWARK, S.E. / PALMER RD., Green St., BETHNAL GREEN, N.E. } LONDON.



HEATHMAN & CO.

TRUCKS in large variety of patterns,

ENDELL STREET,

LONDON, W.C.

a842

J. E. LESTER,

ELECTRICAL ENGINEER,

Electric Light, Private Telephones, Bells, Indicators, &c., fitted and fixed in Factories, Warehouses, Institutions, Business Houses, Hotels, &c.

WRITE FOR QUOTATIONS.

Address—56, BELGRAVE GATE, LEICESTER. 1099

HOW TO BUILD DYNAMO-ELECTRIC MACHINERY,

Embracing Theory, Designing and the Construction of Dynamos and Motors.

By EDWARD TREVERT.

350 Octavo Pages of Working Drawings, Woodcuts, Half-tone Illustrations and practical information about Dynamos and Motors, with Appendices on Field Magnet and Armature Winding, Management of Dynamos and Motors, and Useful Tables of Wire Gauges.

CONTENTS.—Chap. I.—Historical Notes. Chap. II.—Principles of Dynamo-Electric Machines. Chap. III.—Methods of Field Magnet Winding. Chap. IV.—Forms of Field-Magnets. Chap. V.—Armatures. Chap. VI.—How to Make a Toy Electric Motor Chap. VII.—How to Make a Small Dynamo. Chap. VIII.—How to Build a Two-light Dynamo. Chap. IX.—How to Build a One-half Horse-Power Motor or Dynamo. Chap. X.—How to Build a One Horse-Power Motor or Dynamo. Chap. XI.—How to Build a 20-light Dynamo. Chap. XII.—How to Build an Alternating Current Dynamo or Motor. Chap. XIII.—Types of Commercial Dynamos. (Direct current.) Chap. XIV.—Types of Commercial Dynamos. (Alternating current.) Chap. XV.—Types of Commercial Stationary Motors. Chap. XVI.—Types of Commercial Railway Motors. Chap. XVII.—Management of Dynamos and Motors. Appendix A.—Tables of Wire Gauges. B.—Some Practical Directions for Armature Winding. C.—Some Practical Directions for Field-Magnet Winding.

CLOTH BOARDS, POST FREE 10s. 6d., TO BE OBTAINED FROM

H. Alabaster, Gatehouse & Co., 22, Paternoster Row, E.C.

IRON-CLAD RHEOSTATS.

Iron-clad Rheostats take the least room; are perfectly safe; do not burn out; radiate heat quickly, and cannot short-circuit. Very low in price.

USED BY MOST OF THE DYNAMO AND MOTOR MANUFACTURERS OF ENGLAND AND AMERICA.

Motor-starting boxes, with and without "Field-Protecting" device; Speed Regulators; Interlocking and other Dimmers; Special Rheostats, reversing, for Electric Cranes, &c., &c.

SEND FOR COMPLETE CATALOGUE.

STEWART ELECTRICAL SYNDICATE, Ltd.,

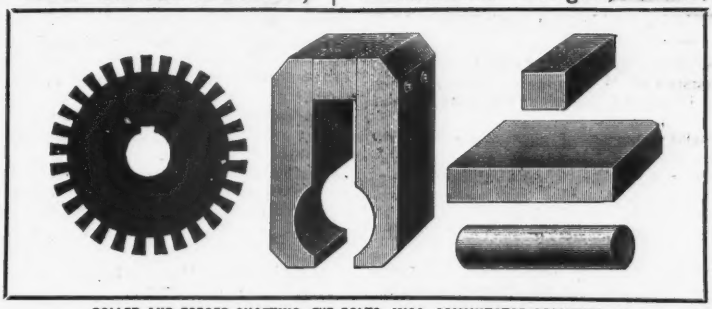
5, NEW COMPTON STREET, LONDON, W.C. a156

TO MANUFACTURERS OF DYNAMOS, MOTORS, TRANSFORMERS, &c.

STAMPINGS OF ALL DESCRIPTIONS, | **MAGNETS—Forged, Rolled, Cast or Stamped, Finished, or in the Rough.**

DISCS up to 60 inches diam.
SLOTTED WORK a specialty.

Accuracy of Stamping and Highest Electrical Results Guaranteed.



SLABS & BARS in Suitable Sections for Magnets, Cold Sawn to lengths.

ROLLED AND FORGED SHAFTING, EYE BOLTS MICA, COMMUTATOR SEGMENTS, &c. a802

ROBERT JENKINS,

88, BISHOPSGATE ST. WITHIN, LONDON, E.C.
Telegraphic Address.—"Permeable, London."

PURE CARBON

"IREX" Brand.

IREX

Leclanche Plates,
Battery Plates,
Crucibles.

APPLY
CARBON SYNDICATE, LTD.,
39 VICTORIA STREET, S.W. a486

THE WALTHAM ENGINEERING CO.,

Art Metal Workers.

SEND FOR NEW

CATALOGUE

OF FITTINGS FOR ELECTRIC LIGHT
(IN FRENCH AND ENGLISH STYLES).
ORNAMENTAL SWITCH COVERS, &c.

98, YORK STREET, WESTMINSTER, S.W.
(Next St. James's Park Station). a982

ELECTRICAL ACCESSORIES

ELECTRICAL ACCESSORIES,
SWITCHES, CUT-OUTS,
DISTRIBUTING FUSE BOARDS
CEILING ROSES,
WALL PLUGS, &c.

MANUFACTURED BY
GEBRUDER JAEGER,
FOR
A. VANDAM & CO.,
SOLE LICENCEES,
39 VICTORIA STREET. LONDON S.W.

ARC LAMPS,
INCANDESCENT LAMPS,
WROUGHT IRON AND BRASS ELECTRIC FITTINGS,
WROUGHT IRON GATES AND RAILINGS. a509

Official Notices.

CITY OF BELFAST.

ELECTRIC LIGHT DEPARTMENT.

THE ELECTRIC COMMITTEE are prepared to receive tenders for the supply and erection of the following plant:

Section B2.—Pumps, Steam, Exhaust and Feed Pipes, &c.

Specification and conditions of contract may be obtained on application to VICTOR A. H. MCCOWEN, Corporation Electrical Engineer, on payment of £1 1s. per copy, which sum will be refunded on the return of the specification, with a *bona fide* tender.

Sealed tenders, endorsed "Tender for ——," must be lodged in my office not later than 10 a.m., Thursday, July 1st, 1897.

The Corporation do not bind themselves to accept the lowest or any Tender.

SAMUEL BLACK,
Town Clerk.
1071

Official Notices.

LEYTON URBAN DISTRICT COUNCIL.

ELECTRIC LIGHT DEPARTMENT.

STONEWARE CONDUITS.

THE ELECTRIC LIGHTING COMMITTEE are prepared to receive proposals for the supply of stoneware conduits. Quantities and particulars may be obtained from the Electrical Engineer, Mr. H. COLLINGS BISHOP, Cathall Road, Leytonstone, and proposals to be sent by post addressed to the undersigned and endorsed "Conduits," not later than Monday, July 5th, 1897.

By Order,
R. VINCENT,
Clerk.

Town Hall, Leyton,
June 19th, 1897.
1099

Official Notices.

VESTRY OF ST. JOHN, HAMPSTEAD.

ASSISTANT ELECTRICAL ENGINEER WANTED.

THE VESTRY are prepared to appoint an Assistant Electrical Engineer to take charge of the running of their electric light station on one of the shifts, and to carry out the instructions of their Chief Engineer.

He must have had practical experience of alternating current station work (preferably with Siemens's alternators and Willans's engines), including synchronising, running in parallel, indicating engines, and testing alternators and cables, getting out cost sheets, efficiencies, &c. He will be required to reside in the parish, and must not engage in any other business or employment. Salary £2 5s. per week.

Applications, stating age and previous experience, together with copies of not more than three testimonials of recent date, to be sent in to me not later than 10 a.m. on 28th June inst.

By Order,
ARTHUR P. JOHNSON,
Vestry Clerk.

Vestry, Hall, Hampstead,
June 14th, 1897. 1065

CORPORATION OF SUNDERLAND.

ELECTRIC LIGHTING STATION.

REQUIRED, the temporary services of a Good Mechanical Draughtsman. Engagement for about two months at a weekly salary of £2 5s. Apply, with copies of two testimonials, to Mr. JNO. F. C. SNELL, Borough Electrical Engineer, on or before the 29th inst.

By Order,
F. M. BOWEY,
Town Clerk.

Town Hall, Sunderland.
June 21st, 1897. 1091

COUNTY BOROUGH OF ST. HELENS.

EXTENSION OF ELECTRICITY WORKS.

THE ELECTRIC LIGHTING COMMITTEE of the Corporation of St. Helen's are prepared to receive tenders for the supply and erection of the following plant for the extension of the Municipal Electricity Works:—

Section A.—Boiler House Plant. Lancashire Boiler and Fittings, Forced Draught Apparatus, Feed Pump, Economiser, &c.
Section B.—Engine House Plant. Steamer Alternator and Exciter, &c., Steam Exhaust, Feed, Blow-off, and Sundry Pipes, Valves, &c.
Section C.—Switchboard and Instruments.
Section D.—Underground Work. Culverts and Cables.
Section E.—Transformer Sub-Stations.

Tenderers are at liberty to tender for any Section or Sections, or for the whole of the Sections, but not for part of a Section.

The Plans of Plant, and Specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. ROBERT HAMMOND, M.I.E.E., the Consulting Engineer to the Corporation, Ormond House, Great Trinity Lane, London, E.C., on and after WEDNESDAY, JULY 1st, 1897, on payment of £2 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a *bonâ fide* tender.

Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to me, at the Town Hall, St. Helens, and be delivered on or before TUESDAY, JULY 20th.

The Committee do not bind themselves to accept the lowest or any tender.

W. J. JEEVES,
Town Clerk.

Town Hall, St. Helens,
June 24th, 1897. 1094

ELECTRIC LIGHTING.

THE METROPOLITAN ASYLUMS BOARD are prepared to receive Tenders for the Supply and Running of Mains in the grounds, and for the Wiring of the Nurses' Quarters now in course of erection at the North-Western Fever Hospital, Haverstock Hill.

A copy of the conditions of contract and specification, prepared by Prof. Ayrton, may be obtained on and after Tuesday, June 29th, at the Chief Office of the Board, Norfolk House, Norfolk Street, Strand, W.C, upon payment of a deposit of £5 in gold or Bank of England note, which will be returned to persons sending in *bonâ fide* tenders.

The deposited plans can be seen at the Hospital any week day between 11 a.m. and 4 p.m. on production of a copy of the specification.

Sealed tenders are to be delivered at the Chief Office of the Board, not later than 11 o'clock on Thursday, July 8th, 1897.

The Board do not bind themselves to accept the lowest or any tender.

By Order,
(Signed) T. DUNCOMBE MANN,
Clerk to the Board.

Chief Office,
Norfolk House, Norfolk St.,
Strand, W.C., *June*, 1897. 1101

Official Notices.

THE URBAN DISTRICT COUNCIL OF MORECAMBE invite applications for the appointment of Resident Electrical Engineer to take charge of and manage the Electricity Works about to be erected.

Applicants must be experienced in the continuous current system, and must be capable of superintending the laying down of the plant, and also of advising and carrying out future extensions.

The salary to be £175 per annum.

The gentleman appointed must devote the whole of his time to the duties of his office.

Particulars of duties, &c., may be obtained from the undersigned, to whom applications, endorsed "Electrical Engineer," must be delivered on or before July 8th next.

JOHN BOND,
Surveyor to the Council.

Council Offices, Morecambe,
June 16th, 1897. 1086

Sale by Tender.

COUNTY BOROUGH OF HUDDERSFIELD.

FOR SALE—50-UNIT GENERATING PLANT.

THE ELECTRIC LIGHTING COMMITTEE of the Huddersfield Corporation have for Disposal a 100 H.P. Compound Vertical Brush Engine, and a 50-unit Mordey Alternator (2,000 volts, 25 amperes).

Full particulars may be obtained upon application to Mr. A. B. MOUNTAIN, Borough Electrical Engineer, St. Andrew's Road, Huddersfield.

Sealed tenders, endorsed "Tender for Purchase of Plant," must be delivered, free of charge, addressed in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, not later than Wednesday, the 14th July, 1897.

The corporation do not bind themselves to accept the highest or any tender.

By order,
F. C. LLOYD,
Town Clerk.

Town Hall, Huddersfield,
June 23rd, 1897. 1102

DOULTON & Co.

Manufacturers of

INSULATORS.

BATTERY JARS,

POROUS CELLS,

AND ALL KINDS OF

POTTERY FOR ELECTRICAL PURPOSES.

LAMBETH, LONDON, S.E. a295

PAUL

MANUFACTURERS OF
Electrical and Physical Instruments.
44, HATTON GARDEN, E.C
Catalogues Free. 2285

SIMPLE THINGS PRODUCE GREATEST RESULTS.

BAYLEY'S

COMMUDINE

Preserves insulation between Sections.
Prevents copper dust adhering.
Reduces Sparking, Brushes wearing, which means less copper dust, and so keeps Commutators in perfect condition, without the aid of oil or grease.
This liquid is pronounced by the most eminent Electrical Engineers to be perfect, and the most useful yet known. Commutators thus treated will wear twice as long, and so save expense, besides trouble.

Used by Railways, leading Electric Lighting Companies, and largest Firms in the kingdom.

The proof of its utility is by testing a bottle, which can be had of any **Electrical General Dealing Firms**, *or of the Manufacturer,* **A. L. Bayley, Moor Green, Birmingham.**

2/- per bottle; post-free, 2/6

PRESSSPAHN

THE INSULATING MATERIAL USED BY THE LEADING MAKERS OF

DYNAMOS, ALTERNATORS, AND TRANSFORMERS.

(MADE IN SHEETS 60 cm. by 80 cm., THICKNESS from 0·2 m/m. to 4 m/m.)

Particulars and Prices can be obtained from

THE INTERNATIONAL TRADING COMPANY,

CORNWALL BUILDINGS, 35, QUEEN VICTORIA STREET, LONDON, E.C.

Sole Agents in the United Kingdom for Dr. Forke & Co., Neuhammer. 10·3

Gold Medal, Paris Exhibition, 1889.

THE BRITISH ALUMINIUM CO., Ltd.,

9, VICTORIA STREET, WESTMINSTER, LONDON, S.W.

PRICE LIST UPON APPLICATION.

BAUXITE MINES,
Glenravel, Co. Antrim.
ALUMINA WORKS,
Larne Harbour.
ALUMINIUM WORKS,
Foyers, Scotland.
ROLLING MILLS & FOUNDRY,
Milton, Staffordshire.
CARBON FACTORY,
Greenock, N.B.

PURE ALUMINIUM

Guaranteed Purity 98—99½ per cent.

Telegraphic Address: "Cryolite, London." Telephone:—3,286.

The British Aluminium Company, Limited, have the Sole Right of Manufacture and Sale of Pure Aluminium produced by the Electric and Electrolytic Processes, and consumers should insist upon all metal purchased bearing this company's trade mark.

AGENTS.
LONDON,
H. R. Merton & Co.,
2, Metal Exchange Buildings, E.C.
NEWCASTLE-ON-TYNE,
Crozier, Stephens & Co.,
32, Collingwood Street.
GLASGOW,
Alexander Brown & Co.,
194, St. Vincent Street.

Bauxite—Hydrate of Alumina and Anhydrous Alumina. Aluminium Ingots, Sheets, Wire, Tubes, Angles, Castings, Forgings, Stampings, Solder, &c., &c. Wolframinium, Romanium, and other Light Aluminium Alloys, in Castings, Sheets, Angles, &c.; strong as brass, cast-iron, &c. Aluminium Bronze; strong as steel; tough as wrought-iron. Speciality—Propellers and Propeller Blades. Carbon for Electrolytic Purposes. 10·42

POST FREE, 7s. 6d.

Applied Magnetism:

AN INTRODUCTION TO THE DESIGN OF ELECTRO-MAGNETIC APPARATUS.

By J. A. KINGDON, B.A., formerly Math. Schol., Pemb. Coll., Oxon.

75 ILLUSTRATIONS, MANY ORIGINAL; SEVEN TABLES.

CONTENTS.—Chap. I., General Principles of Magnetism; Chap. II., The Electromagnetic Units; Chap. III., Magnetomotive Force of Current; Chap. IV., Magnetic Traction; Chap. V., Generation of Electromotive Force; Chap. VI., Qualitative Magnetism; Chap. VII., The Alternator; Chap. VIII., The Dynamo; Chap. IX., Magnets and Magnetic Leakage; Chap. X., Commutators and Collectors; Chap. XI., Hysteresis and Heating of Armatures; Chap. XII., Alternating Magnetic Flux; Chap. XIII., Electromotors; Chap. XIV., Polyphase Currents and Rotary Fields; Chap. XV., Magnetic Measurements; Chap. XVI., Calculations in Inch Measures. Appendices:—I., Dimensions of Fundamental, Derived and Electromagnetic Units; II., Symbols and Formulæ. Index.

H. ALABASTER, GATEHOUSE & CO., 22, PATERNOSTER ROW, LONDON, E.C.

CLOTH, 6s. 6d. POST FREE.

NEW BOOK ON

ELECTRO-THERAPEUTICS.

Valuable Contributions by Learned Men on Live Subjects.

Proceedings of the Boston Meeting of The American Electro-Therapeutic Association.

Some of the Subjects:

"Meters," "Induction Coils," "Static Electricity," "Electrodes," "Generators and Controllers," "The Electric Light in Therapy," "Electricity Instead of Surgery," "Electricity in Diseases of the Throat and Nose," "In Diseases of the Larynx," "Accidents in the Use of Street Currents," "Direct Electrisation of the Stomach," "Electricity in the Treatment of Apoplexy," "Electricity in Treatment of the Nerves," "Electricity in Treatment of Stricture," "Results in Eighty-Six Fibroid Cases," and many others.

H. ALABASTER, GATEHOUSE & CO., 22, PATERNOSTER ROW, LONDON, E.C.

Telegraphic Address:—"SOLAR, BIRMINGHAM."

CHAMBERLAIN & HOOKHAM, Ld. ELECTRICAL ENGINEERS, BIRMINGHAM.

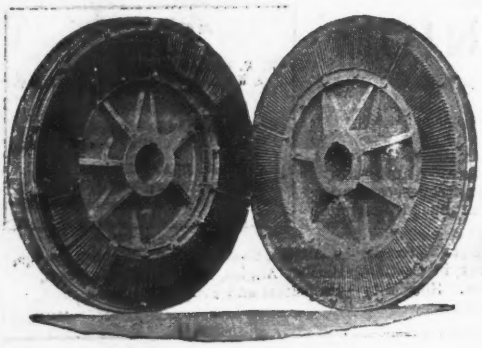
ELECTRICITY METERS

The Best in the Market.
Approved by the Board of Trade.
Patents Upheld in Court of Queen's Bench.

MANUFACTURERS AND OTHERS INFRINGING THE COMPANY'S PATENTS WILL BE PROCEEDED AGAINST.

Agents for Great Britain & Ireland: MESSRS. VENNER & SILLAR, 10, Delahay Street, Westminster, S.W. Telegraphic Address: "Trydan, London."

ELASTIC CLUTCH OR COUPLING.



(PATENT.)

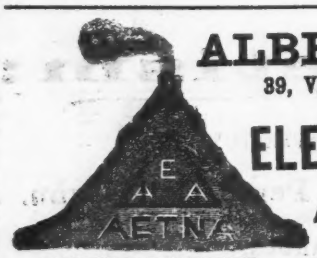
Suitable for High or Low speeds.
Made also as Fast and Loose Pulley.
Specially applicable for Electrical Work.

OVER 100,000 H.P. AT WORK.

COWLISHAW, VALKERE & CO., LTD.,

Engineers and Ironfounders
ETRURIA, STOKE-ON-TRENT.

AGENTS WANTED WHERE NOT ALREADY REPRESENTED. 103



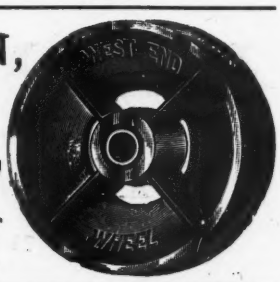
REGISTERED TRADE MARK.

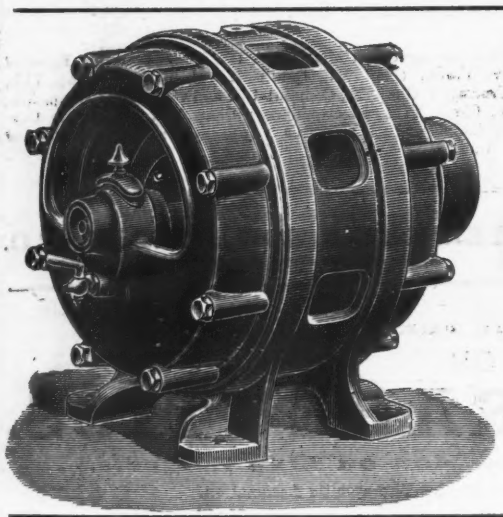
ALBERT & J. M. ANDERSON,

39, VICTORIA STREET, WESTMINSTER, LONDON S.W.
Manufacturers of

ELECTRIC TRAMWAY SUPPLIES,

"AETNA" Insulators and Hangers,
ANDERSON'S STANDARD LINE MATERIAL.
TROLLEYS, LIGHTNING ARRESTERS, &c.,
EVERY REQUISITE FOR OVERHEAD LINE CONSTRUCTION. 9497





FULLER & CO.,

28, BUSH LANE.

SELF-STARTING ALTERNATING CURRENT MOTORS

To be seen running at the above address.

SEND OR WRITE FOR PRICE LISTS.

WORKS:
252, MAIN ST.,
BRIDGETON,
GLASGOW.

Telegrams:— "Laminated, Glasgow."

HENDRY'S PATENT LAMINATED LEATHER BELTING.

Endless Belts for Electrical Plant a speciality.
"THE ACME OF DYNAMO DRIVING."

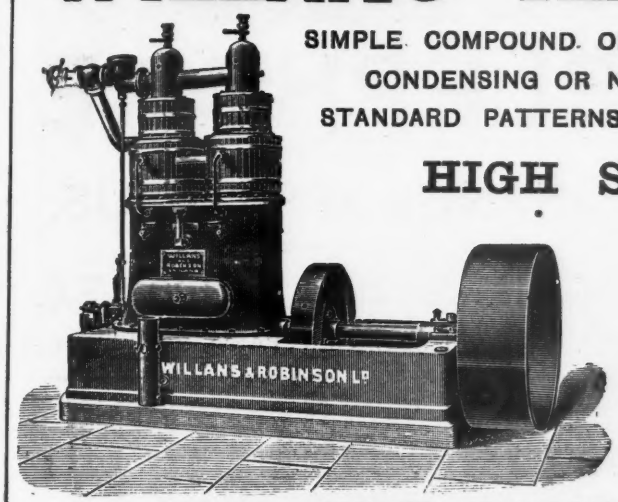
NO SLIP,
NO NOISE,
NO STRETCH.

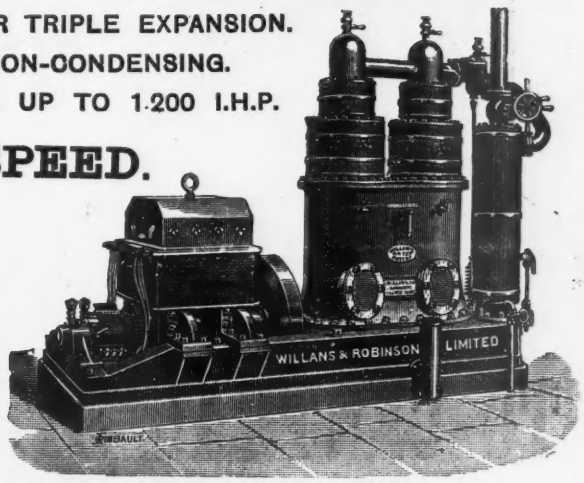
WRITE FOR Illustrated Price List. 9811

WILLANS CENTRAL VALVE ENGINES

SIMPLE COMPOUND OR TRIPLE EXPANSION.
CONDENSING OR NON-CONDENSING.
STANDARD PATTERNS UP TO 1,200 I.H.P.

HIGH SPEED.





EXTREME ECONOMY OF STEAM.

(A consumption of less than 13 lbs. per I.H.P. per hour has been recorded under suitable conditions of size, pressure, &c., and even in Engines of 80 I.H.P. a consumption of less than 14½ lbs. can be guaranteed with 160 lbs. pressure.)

GREAT SAVING OF OIL. LITTLE ATTENDANCE REQUIRED.

SMALL SPACE OCCUPIED and corresponding reduction in first cost of buildings.

SILENCE AND DURABILITY, OWING TO ALL BRASSES BEING IN CONSTANT THRUST.

Over 175,000 H.P. in use or on order.

WILLANS & ROBINSON, LTD., RUGBY, WARWICKSHIRE.

a888

Swedish Charcoal Iron Sheets and Stampings.

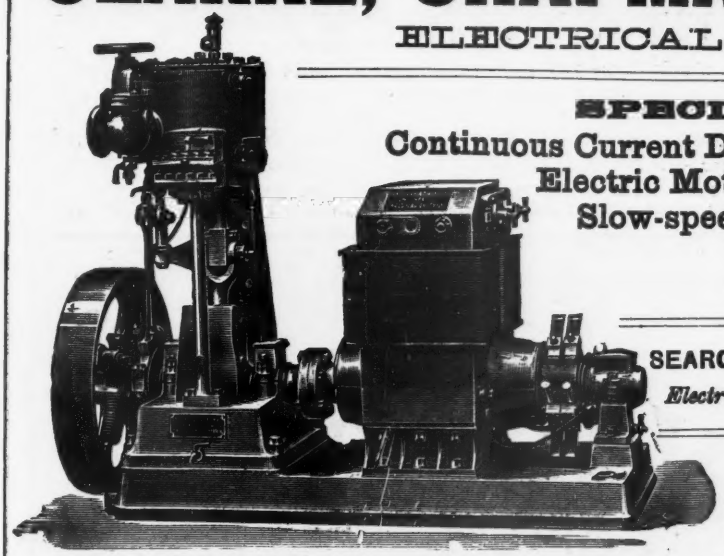
TURNER BROS., 134, UPPER THAMES ST., LONDON.

Telegraphic Address. "CHESTERTON, LONDON." a116

FORGINGS FROM THE HAMMER, & MACHINED TO ANY DIMENSIONS.

CLARKE, CHAPMAN & CO., Ltd.,

ELECTRICAL ENGINEERS.



SPECIALITIES.

Continuous Current Dynamos, Alternators,
Electric Motors,
Slow-speed Direct-coupled
Engines and Dynamos
For Ship Lighting, &c.

SEARCH LIGHT PROJECTORS, ARC LAMPS

Electric Lighting and Power Transmission.

CONTRACTORS TO ADMIRALTY.

GATESHEAD-ON-TYNE.

[ENGINEERING TELEGRAPH CODE USED.] a917

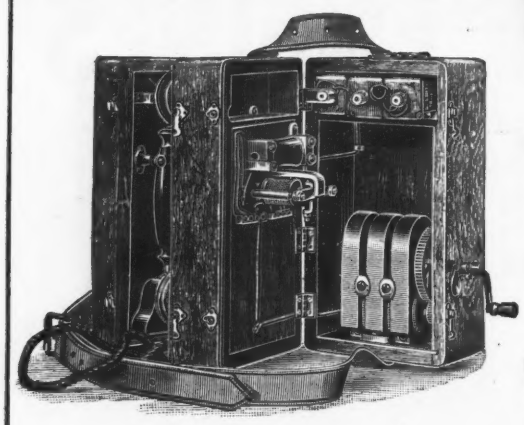
Established 1827. Telegraphic Address: "Unsworth, Derby.

G. B. UNSWORTH. GREEN LANE MILLS DERBY,

Manufacturer of Electrical Wires of every description for Electrical Instruments, Dynamo Machines, Telephones, and Electric Bells.

INSULATED LINE WIRES AND CABLES.

London Agents:—JOHN DAVIS & SON, 118, Newgate Street, E.C. a921



WESTERN ELECTRIC CO.,

MANUFACTURERS OF

TELEPHONE

and

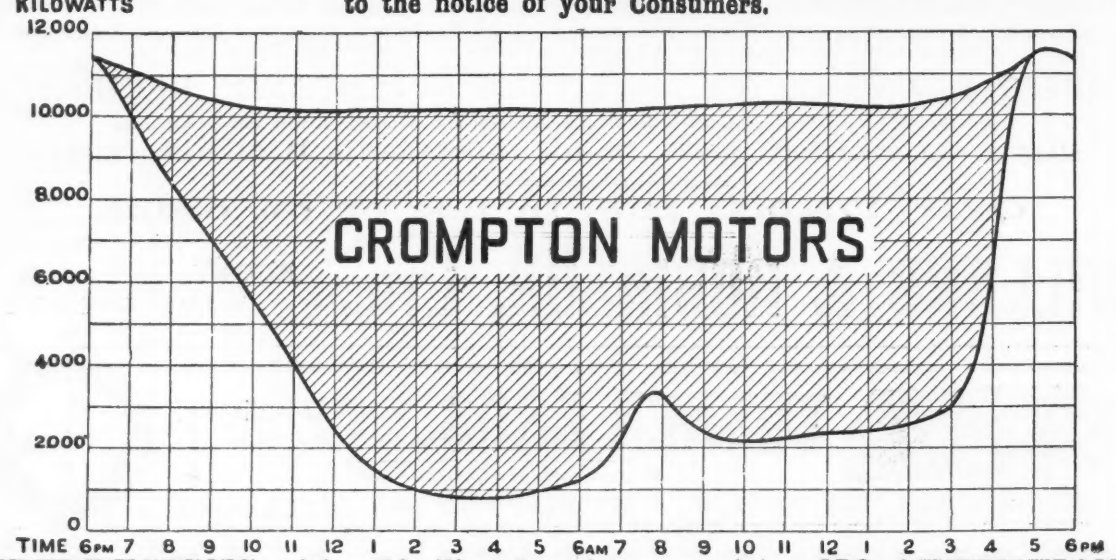
EXCHANGE APPARATUS.

79, COLEMAN STREET, LONDON, E.C.

CHICAGO, NEW YORK, ANTWERP, PARIS, & BERLIN. 1906

TO CENTRAL STATION ENGINEERS.

Improve your Load Factors by introducing CROMPTON MOTORS to the notice of your Consumers.



NEW DESIGNS with self-oiling bearings requiring NO ATTENTION

MODERATE SPEED, NO HEATING OR SPARKING,

AND ABOVE ALL

HIGH EFFICIENCY.

1½ H.P. size now ready for delivery from stock, 100—110 volts or 200—220 volts, 1,200—1,400 revs.

¼, ½, 1 and 2 H.P. sizes ready shortly.

APPLY FOR FULL PRICE LISTS AND INFORMATION TO

CROMPTON & CO., LTD., Mansion House Buildings, London, and Arc Works, Chelmsford.

Cooking and Heating Department—35, QUEEN VICTORIA STREET, LONDON.

CKET PRICE LIST AND USEFUL FORMULÆ (Including Magnifying Glass), Post Free, 13 Stamps.
CROMPTON'S (Trotter's Patent) WIRING SLIDE RULE, 2s., Cloth, Case, 2s. 6d., Leather Case, 3s. 896

USED EVERYWHERE.

THE "ROYAL" INCANDESCENT LAMPS.

APPLY TO—

A. & W. HOPKINS,

30 Parliament Street,

LONDON, S.W.

10402

IN ORDER TO COPE WITH

INCREASING VOLUME

OF

BUSINESS

THE

E.P.S. Co., Ld.,

HAS ADDED

And is now equipping premises having an area of about

16,000 SQUARE FEET

TO ITS

MILLWALL WORKS.

These additions to the works will shortly enable the company to give

QUICK DELIVERY

And avoid delay in execution

OF ORDERS.

OFFICES: 4, GREAT WINCHESTER STREET, LONDON, E.C.

10184

SIEMENS BROTHERS & Co.,

LIMITED.

Electrical and Telegraph Engineers.

MANUFACTURERS OF

India-Rubber, Gutta-Percha and Lead-Covered Cables and Wires for Telegraph, Telephone, and Electric Light Work.

MATERIALS FOR LAND LINES, IRON TELEGRAPH POSTS. INSULATORS INSTRUMENTS. BATTERIES

Electric Mine Exploders, Torpedoes, Torpedo Apparatus,

POLICE, FIRE AND RAILWAY SIGNALS AND BLOCK APPARATUS,

DYNAMOS & ALTERNATORS,

REVERSIBLE MOTORS, TRANSFORMERS,

ARC LAMPS, AMMETERS, VOLTMETERS &c., &c.

ELECTRIC APPARATUS OF ALL KINDS.

CONTRACTORS FOR

SUBMARINE CABLES,

LAND LINES,

SHIP LIGHTING & ELECTRIC LIGHT IN MILLS, FACTORIES, &c.,

ELECTRIC RAILWAYS & TRAMWAYS,

Transmission of Power by Electricity,

CENTRAL STATIONS

SOLE MANUFACTURERS IN ENGLAND OF HELLESEN'S AND OBACH'S DRY BATTERIES.

AGENTS FOR "SIEMENS" GLOW LAMPS & MENEELY TUBULAR BEARINGS.

OFFICES:

London: 12, QUEEN ANNE'S GATE, WESTMINSTER, S.W.
Newcastle: 15, VICTORIA BLDGS., GRAINGER ST. WEST.
Glasgow: 261, WEST GEORGE STREET.
Melbourne: 46 and 48, MARKET STREET.

Works:—WOOLWICH, KENT.

Cable Address: "SIEMENS, LONDON." Codes: A.B.C., A1, Engineering.

647

THOMAS BOLTON & SONS,

COPPER SMELTERS & MANUFACTURERS.

WORKS: OAKAMOOR, NORTH STAFFORDSHIRE.
MERSEY COPPER WORKS, WIDNES.
BROAD STREET METAL WORKS, BIRMINGHAM.
FROGHALL COPPER WORKS, STAFFORDSHIRE.
SUTTON ROLLING MILLS (Newton, Keates & Bolton), ST. HELENS

LONDON OFFICE: 90, CANNON STREET (W. Lee Mathews).

TELEGRAPH ADDRESSES:—"WIREDRAWN, LONDON." "BOLTON, OAKAMOOR." "ROLLS, WIDNES." "BOLTONS, BIRMINGHAM." "MACTEAR, SUTTON OAK."

COPPER

HIGHEST CONDUCTIVITY FOR ALL

ELECTRICAL PURPOSES.

GREATEST TENSILE STRENGTH AND DUCTILITY.

COPPER WIRE.	TROLLEY WIRE.	COPPER CABLES.
COPPER STRIP.	TELEGRAPH WIRE.	TINNED WIRE.
ELECTRIC MAINS.	TELEPHONE WIRE.	FINE WIRE.
COMMUTATOR BARS.	STENCIL COPPER.	DIAL COPPER.
COPPER TUBES.	PRINTING ROLLERS.	COPPER CYLINDERS.
BRASS TUBES.	BRASS SHEETS.	COPPER FORGINGS.
COPPER SHEETS.	BRASS WIRE.	BRASS RODS.
COPPER PLATES.	SOLDER.	ALUMINIUM TUBES.
COPPER RODS.	WEAVING WIRE.	ALUMINIUM SHEETS.
COPPER PANS.	GERMAN SILVER.	ALUMINIUM WIRE.

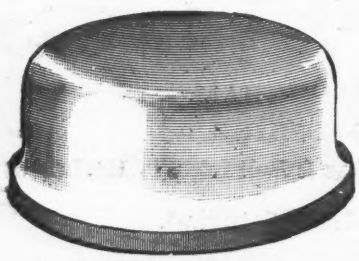
Contractors to the Home, Indian and Colonial Government Departments, and to the Leading Cable Manufacturers and Electrical Engineers, British and Foreign Railway Companies, Telephone and Electric Lighting Cos., &c., &c.

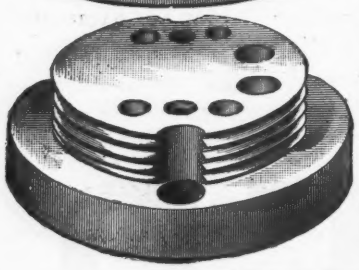
BULLERS LIMITED,

MANUFACTURERS OF

PORCELAIN INSULATORS

OF ALL KINDS.



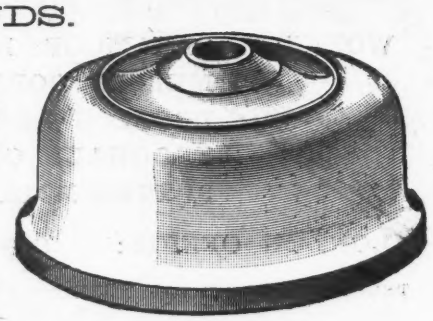


CONTRACTORS TO

M.H. POST OFFICE, INDIA, CROWN AGENTS and AGENTS-GENERAL for the Colonies, RAILWAYS and TELEPHONE COMPANIES.

MANUFACTURERS OF

PORCELAIN for Electric Light Fittings, SWITCHES, CUT-OUTS, CEILING ROSES, WALL PLUGS, D.P. CUT-OUTS, PULLEYS, TUBES, INSULATORS for Underground Mains, PORCELAIN SLABS for Main Switches, superseding enamelled Slate and Earthenware.



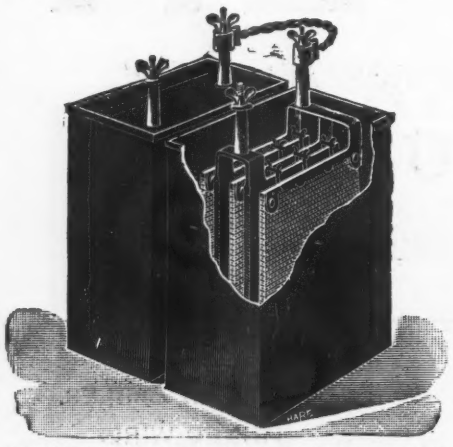
ALL THESE GOODS MADE IN PURE

VITREOUS PORCELAIN,

GIVING THE HIGHEST INSULATION—INDISPENSABLE FOR DAMP PLACES.

9297

London Office: 32 & 33, QUEEN STREET, E.C. WORKS:— **HANLEY and TIPTON**



CARRIAGE TYPE "C" 5.—Total weight, 23 lbs.; Capacity, 80 ampere hours at a discharge rate of 20 amperes. Overall Dimensions, 7-in. × 4-in. × 12-in. 100 ampere hours at half rate discharge.

THE LAMINA ACCUMULATOR

The Only Suitable Cell for AUTO-CARS.

Planté Principle, YET lighter than any paste cell in existence

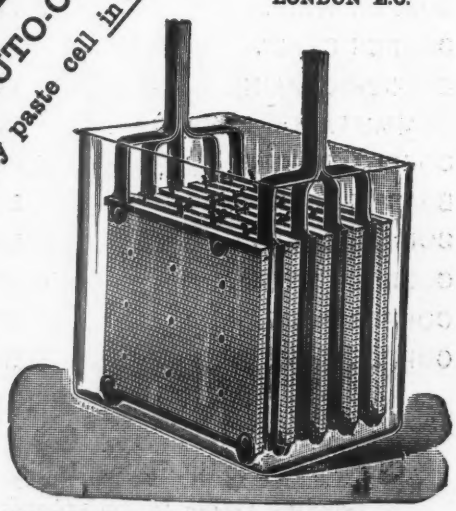
Write for New List and Full Particulars to the

LAMINA ACCUMULATOR

(Elieson's British Patents)

SYNDICATE, LIMITED,

Broad Street Avenue, LONDON E.C.



LIGHTING TYPE "A" 9.—Total weight, 71 lbs.; Capacity, 320 ampere hours at a discharge rate of 40 amperes. Overall Dimensions, 8-in. × 10½ in. × 12-in. 420 ampere hours at half rate discharge

9411

TUDOR ACCUMULATORS

SOME OF THE CENTRAL STATIONS IN WHICH TUDOR ACCUMULATORS ARE USED.

GREAT BRITAIN.

Edinburgh
Glasgow
Llandrindod Wells

LONDON:—
Westminster:
Eccleston Place
Davies Street
Millbank
Leyton

Northampton
Plymouth
Portsmouth

FRANCE.

Beaucourt
Bordeaux
Carcassonne
Lavardac
Lyons
Narbonne
Nice

PARIS:—
Clichy
Edison
Popp

Rouen
St. Etiénne
Sedan
Vichy

GERMANY.

Aix-la-Chapelle
Barmen
Berlin
Bremen
Breslau
Cassel
Düsseldorf
Gera
Hamburg
Hanover
Königsberg
Leipzig
Mulhouse
Stuttgart
Wiesbaden

AUSTRIA-HUNGARY.

Budapest
Prague
Serajevo

VIENNA:—
Neubad
Mariahilf

ITALY.

Ferrara
Genoa
Mantua
Naples
Ventimiglia

SWITZERLAND.

Berne
Montreux
Rheinfelden
St. Gallen
Zug

SPAIN.

Barcelona
Lérida
Pampeluna
San Sebastian
Valentia

BELGIUM.

Brussels
Ghent
Liége

HOLLAND.

Groningen
Rotterdam
The Hague
Utrecht

COLONIES & AMERICA

Boston
Buenos Ayres
Cape Town
Valparaiso

Christiania
Copenhagen
Jerez
Luxemburg
Omsk
Stockholm

OVER 6,000 BATTERIES.

Works: DUKINFIELD, Near MANCHESTER.

A. B. PESCATORE.

Offices: 5, CROSS ST., MANCHESTER.

CONTRACTOR TO THE WAR DEPARTMENT.

4230

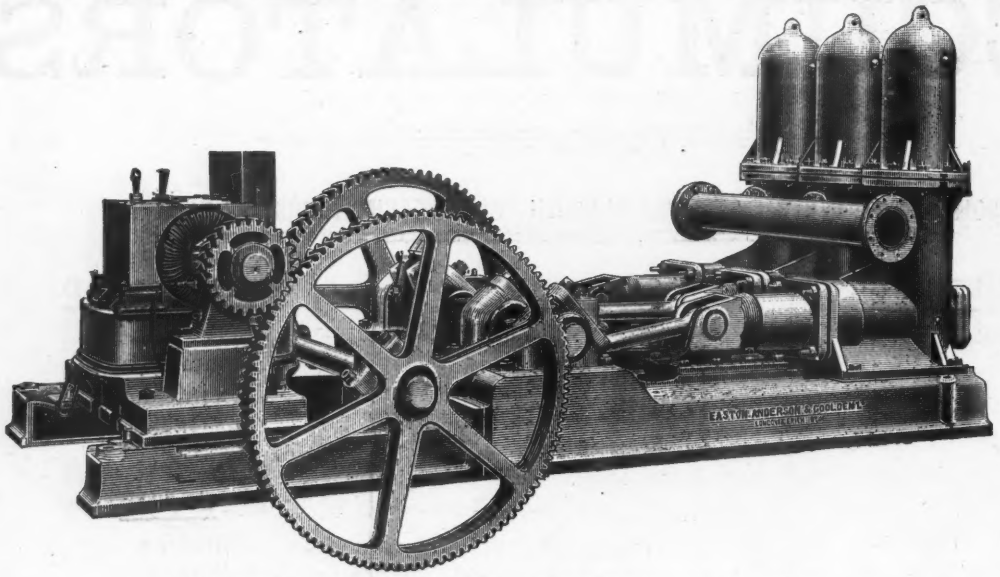
EASTON, ANDERSON & GOOLDEN, LIMITED.

HEAD OFFICE:—ERITH IRONWORKS, ERITH, Kent.
Telegrams:—"EASTONS ERITH." Telephone:—DARTFORD, No. 4.

LONDON:—Broad Sanctuary Chambers, Broad Sanctuary, S.W.
Telegrams:—"EGYPTIAN, LONDON." Telephone:—545 Westminster.

NEWCASTLE-ON-TYNE:—2, St. Nicholas Buildings.

CARDIFF:—Western Mail Buildings.



MOTOR AND THREE THROW PUMP FOR
THE MAY CONSOLIDATED GOLD MINING COMPANY.

ELECTRIC MINING MACHINERY.

PATENT ENCLOSED MOTORS FOR COLLIERIES.

ELECTRIC COAL CUTTING.

ELECTRIC LIGHT & POWER.

HIGH SPEED ENGINES.

ELECTRIC LIFTS AND CRANES.

ELECTRIC TRACTION.

BOILERS.

9983

THE BRITISH THOMSON-HOUSTON CO.,

LIMITED

ENGINEERS & CONTRACTORS

For all Standard Electrical Apparatus for Traction, Lighting, Power and Industrial Applications.

Generators FOR

ARC AND INCANDESCENT LIGHTING,
RAILWAYS,
TRAMWAYS,
POWER TRANSMISSION.

Motors FOR

RAILWAYS,
TRAMWAYS,
MILLS,
WORKSHOPS,
HOISTS, PUMPS.

ROTARY CONVERTERS, TRANSFORMERS, ARC LAMPS.

THOMSON RECORDING WATTMETERS.

Head Office:—

83, CANNON ST., LONDON, E.C.

ELECTRIC CABLE CASINGS.

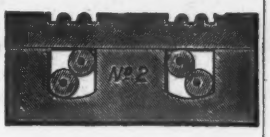
ALL MADE TO THIS PATTERN.

The prices quoted below are per 100 ft., case and cover together.

Full Size Sections on Application.

ESTIMATES FOR OTHER WOODS AND SIZES PROMPTLY SENT.

Switch Blocks and Cleats Made to Order.



Size No. . .	1	Small 2	2	3	4	5	6	7	8
Width . . .	1½"	1¼"	1¼"	1⅜"	2"	2½"	3"	3½"	4"
Grooves . .	⅛"	3/16"	⅛"	⅛"	⅛"	⅛"	⅛"	⅛"	⅛"
For B.W.G.	18	16	*16	14	7/20	7/16	7/14	19/16	19/12
Whitewood	2/10	8/-	3/1	3/11	4/5	6/6	9/4	11/8	18/7
Deal	2/5	—	2/10	3/6	4/-	5/9	8/4	10/-	14/-

* Or Two Pairs of No. 18 B.W.G.

Trade Allowance { 5 per cent. for 5,000 feet or over. 10 " " " 10,000 " "

VIGERS BROS., EXPORTERS OF SPECIALITIES IN FLOORING & FLOORING BLOCKS.

50, KING WILLIAM ST., LONDON, E.C. 5118

BEECROFT & WIGHTMAN,

Makers of Electric Casings and Covers.

Telegrams: Beecroft, Wightman, Bradford, London Exchange, London. McGeoch, Glasgow. National Telephone, Bradford, No. 42.

Stocks kept in London. Agent: Mr. A. Campbell, 28, Gray's Inn Rd., W.C. Agents for Scotland: Messrs. W. McGeoch & Co. 106, Argyle St., Glasgow.

WOOD-MOULDING MILLS, HARRIS ST., and GARNETT ST., BRADFORD.

JOHNSON & PHILLIPS,

15, Union Court, Old Broad St., E.C., and Charlton, Kent.

MAKERS of the most modern machines for

CABLE MAKING. | CABLE LAYING.
STRANDING. | BRAIDING.
TAPING. | WINDING.
COMPOUNDING. | LAPPING.

RUBBER, SILK & COTTON COVERING 386

The INDIAN and EASTERN ENGINEER.

AN ILLUSTRATED WEEKLY JOURNAL FOR ENGINEERS IN INDIA AND THE EAST.

The "INDIAN AND EASTERN ENGINEER" contains the latest and most authentic information on all subjects connected with Engineering enterprise in India and the East.

Correspondence invited on any subject which may be of interest to the profession.

RATE OF SUBSCRIPTION (payable in advance, including a copy of the INDIAN AND EASTERN ENGINEER'S DIARY, and postage):—

Indian Rates—Yearly Rs. 20. English Rates—Yearly 40s.

Published at 137, Canning Street, Calcutta.

London Office: 28, *VICTORIA STREET, WESTMINSTER, S.W* 9581

Mr. J. G. LORRAIN, M.I.E.E., M.I.M.E. &c.

Fellow of the Chartered Institute of Patent Agents,

Norfolk House, Norfolk St., London, W.C.

"PATENTEE'S HANDBOOK" Post Free on Application. 409

RAMSDEN, CAMM & CO., LTD.,

BRIGHOUSE, YORKSHIRE,

Iron, Steel and Copper Wire Drawers,

MANUFACTURERS OF

TELEGRAPH, TELEPHONE AND CABLE WIRE,

Contractors to H.M. Postmaster-General, the Indian and Colonial Governments and leading Railway Companies

SPECIALITIES:—FINE SIZES OF H.C. COPPER, GERMAN SILVER, &c., WIRES 681

The Chloride Electrical STORAGE Syndicate, Limited,

is glad to inform its numerous clients, and the Trade generally, that, owing to the recent unprecedented demand for its manufactures, and the consequent increase of output, it is under no necessity to advance its present prices for

BATTERIES OR CELLS

in spite of the rise in cost of raw material.

CLIFTON JUNCTION, NEAR MANCHESTER. 7569

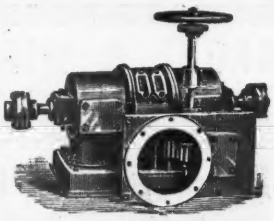
LUNDBERG'S
ELECTRIC LIGHT FITTINGS.
18 years' experience.

Original designs in Switches and Cut-outs. Wall and Floor Sockets, Switch and Fuse Boards, Ceiling Roses, &c.
SPECIAL REQUIREMENTS WORKED OUT.

A. P. LUNDBERG,
Bradbury Electrical Works,
BRADBURY ST., KINGSLAND, LONDON, N.
Telegraphic Address: "Lundberg, London." a175

J. H. RIGG,
ENGINEER AND ELECTRICIAN,
Inventors' Modeller & Scientific Apparatus Manufacturer,
43, SKINNER LANE (Works: Cross Stamford St. and Telephone St.), LEEDS.
Telegraphic and Cable Address: "MOTOR LEEDS." a823

HIGH EFFICIENCY
TURBINES
"LITTLE GIANT." DOUBLE TURBINES.

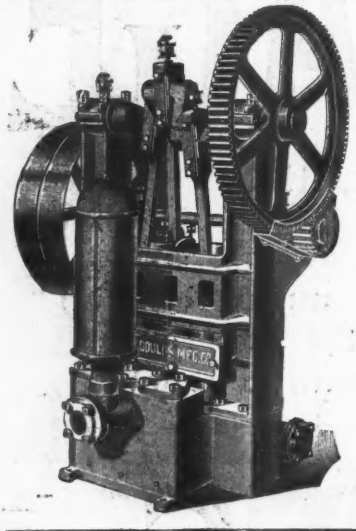


PELTON WHEELS
CENTRIFUGAL PUMPS, &c.

S. HOWES, MECHANICAL ENGINEER
64, MARK LANE, LONDON, E.C.
Contractor to H.M. Government, also to the Russian, French, Dutch, Turkish, Egyptian, Indian, and Cape Governments.

JUST PUBLISHED. With 146 Illustrations, demy 8vo. Cloth. Price **10s. 6d.**
THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING.
By W. E. LANGDON,
Member of the Institution of Electrical Engineers; Superintendent and Engineer of the Electrical Department of the Midland Railway, England.
a852
London: E. & F. N. SPON, Ltd., 125, STRAND. New York: SPON & CHAMBERLAIN.

INSULATORS
Of all descriptions, combining the greatest strength with highest possible insulation, in Bristol Glazed Stoneware and Special Porcelain Stoneware (White).
ALSO BATTERY JARS PRIMARY AND SECONDARY AND POROUS CELLS.
PRICE, SONS & COMPANY, The Potteries, **BRISTOL.**



ELECTRIC DRIVEN TRIPLEX PUMPS.
A Large Stock always on hand ready for immediate delivery.
A VERY LARGE VARIETY OF TYPES SUITABLE FOR EVERY PURPOSE.
One Order for 37 of these (large size) now being shipped.
ALSO THE
VICTOR TURBINE.
FREDERIC NELL, 97, Queen Victoria Street, LONDON.
a6 90

INCANDESCENT LAMPS,
Warranted English make; from 2 to 220 Volts, in all Candle-Powers.
ECONOMIC LAMPS OF SMALL CONSUMPTION OF POWER AND PROPORTIONATELY SHORTER DURATION, OR LAMPS OF LONGER DURATION AND INCREASED CONSUMPTION, AS REQUIRED.
A LARGE STOCK OF ORDINARY VOLTAGES ON HAND. EVERY SIZE AND SHAPE TO ORDER.
All Lamps tested before despatch. Caps fitted to suit any holders in ordinary use.
MACKEY, MACKEY & CO., Manufacturers, 175, GRANGE ROAD, BERMONDSEY, S.E.
a309

THE COX GENERATOR

ELECTRICITY DIRECT FROM HEAT.

THE CHEAPEST KNOWN METHOD.
NEEDS NO ATTENTION.
NO DANGER FROM SHORT CIRCUIT.
NO CHEMICALS—NO DIRT.
NOTHING TO GET OUT OF ORDER.
ABSOLUTELY NO POLARIZAT ON

Not an Experiment, but a Demonstrated Fact.

The nearest to perfection as a means of generating electricity. It consumes ordinary illuminating gas from an ordinary burner, and can be attached to the wall of any room. It is ornamental in appearance, and the type illustrated is suitable for any small power, such as is required for **operating Ventilating Fans, Small Motors, Electric Bells, Medical Apparatus, X-Ray Apparatus, Induction Coils, Electro-Plating, Telephone, Telegraph, Fire Alarm Signals, and for Charging Accumulators, &c., &c.**

IT SUPERSEDES THE PRIMARY BATTERY.

Write for Illustrated Catalogue with Price List and General Information.

THE COX THERMO-ELECTRIC CO., LTD.

ADDRESS COMMUNICATIONS TO
THE COX LABORATORY,
ST. ALBANS-HERTS.

LONDON OFFICE:
4 VICTORIA MANSIONS
WESTMINSTER S.W

a909

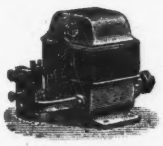
DYNAMOS AND MOTORS IN SMALL SIZES.

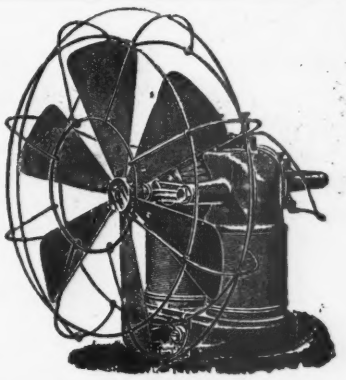
TABLE or BRACKET FANS for Ships' Cabins, &c.

HAND DYNAMOS for Experimental and Lecture Purposes.

DYNAMOS FROM 8 WATTS TO 2,800 WATTS for Lighting, Charging, Plating, &c.

MOTORS from $\frac{1}{10}$ to 3 H.P.





THE CRYPTO WORKS CO., Ltd.,

MANUFACTURERS

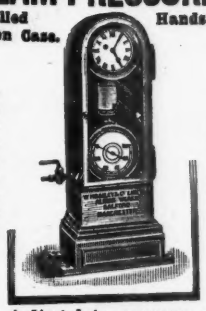
29, CLERKENWELL ROAD, LONDON E.C.

Telegrams: "Commutator, London." 10158

BAILEY'S
PATENT STEAM PRESSURE RECORDER

Enclosed in Enamelled Iron Case.

Handsome in Finish and Appearance.



Fitted with best English Eight-Day Movement, and all the latest improvements. Is an accurate recorder of the fluctuations of the boiler pressure, and an effectual check on carelessness and extravagance in firing.

Modifications of this instrument made for Water, Hydraulic, Blast, Fan, Vacuum and other pressures; also for recording speeds of Engines, Machines, &c., for recording the water level of Reservoirs, &c.

Price, with Gauge indicated to pressures of 100, 150, 200 *or* 250 *lbs. (as ordered)* **£12 10s.**

W. H. BAILEY & CO., LTD.,

ALBION WORKS, SALFORD **MANCHESTER.** Telegrams:—"Beacon Salford." 6630

London Office & Showrooms:—
7, VICTORIA EMBANKMENT (Opposite Queen Victoria Street), BLACKFRIARS, E.C

"The representative of advanced science."—*Pall Mall Gazette.*

SCIENCE PROGRESS:

A QUARTERLY REVIEW OF CURRENT SCIENTIFIC INVESTIGATION.

Edited by J. BRETLAND FARMER, M.A.,
WITH THE CO-OPERATION OF A POWERFUL EDITORIAL COMMITTEE.

CONTENTS OF APRIL NUMBER.

ON THE PHYSIOLOGY OF REPRODUCTION IN PLANTS. By H. Marshall Ward, D.Sc., F.R.S., Professor of Botany in the University of Cambridge.
CONDENSATION AND CRITICAL PHENOMENA (II.). By J. P. Kuenen, Ph.D., Professor of Physics in University College, Dundee.
A REMARKABLE ANTICIPATION OF MODERN VIEWS ON EVOLUTION. By E. B. Poulton, M.A., F.R.S., Hope Professor of Zoology in the University of Oxford.
THE DISEASES OF THE SUGAR CANE. By C. A. Barber, M.A., Late Superintendent of Agriculture in the Leward Isles.
WIND-SCORPIONS—A BRIEF ACCOUNT OF THE GALEODIDÆ. By H. M. Bernard, M.A.
THE CELL-MEMBRANE. By J. Reynolds Green, ScD., F.R.S., Professor of Botany to the Pharmaceutical Society of Great Britain.
THE COAGULATION OF THE BLOOD (III). By W. D. Halliburton, M.D., F.R.S., Professor of Physiology in King's College, London.
ON THE RELATION BETWEEN THE FORM AND THE METABOLISM OF THE CELL. By Max Verworn, Ph.D., Professor of Physiology in the University of Jena.
APPENDIX—REVIEWS OF BOOKS.

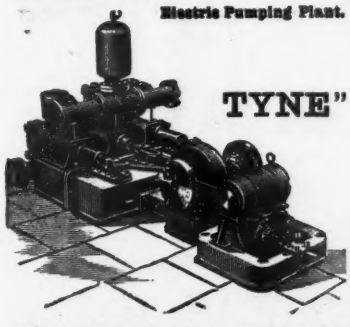
Price 3s., or 3s. 3d. post free. Subscription 10s. 6d. per annum, post free.
Vols. I., II., III., IV. and V., in handsome Cloth Binding, gilt lettered, each containing over 500 pages. Price 16s. each.

London:—
THE SCIENTIFIC PRESS, Ltd., 28 & 29, Southampton St., Strand, W.C.

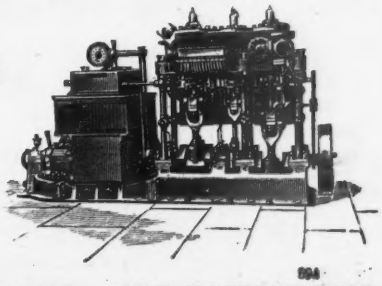
ERNEST SCOTT & MOUNTAIN, LIMITED.

Newcastle-on-Tyne.

Electric Pumping Plant.



"Admiralty" type Combined Engine & Dynamo.



SOLE MAKERS OF

TYNE" DYNAMOS & MOTORS,

High Speed Steam Engines,
Steam and Electrical Fans and Pumps,
Electric Lighting Installations.
Electric Pumping and Hauling,
Electric Coal Cutting.

Contractors to H.M. and Foreign Governments.

London Office:—20, NEW BRIDGE ST. BLACKFRIARS, E.C.

894

ELECTRIC TRANSMISSION OF POWER MACHINERY.

PARIS, 1889.

Estimates given on receipt of patterns or prints

PARIS, 1889

Davis & Timmins

34A. YORK ROAD, KING'S CROSS N. London.

Manufacturers of
Metal Screws & Turned Work
by Automatic Machinery for
Engineers & Electricians

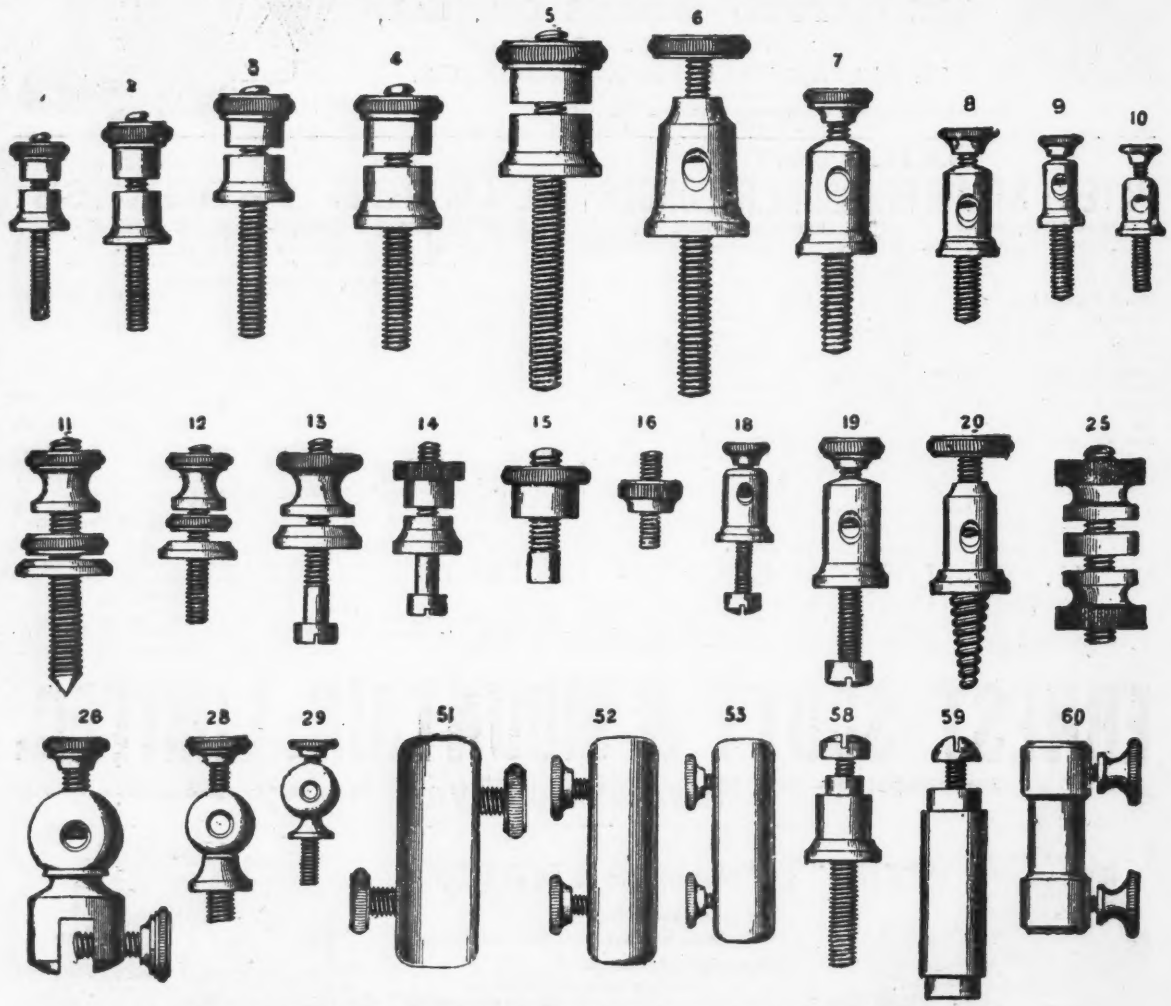
CONTRACTORS TO H.M. GOVERNMENT,
THE WAR OFFICE, ADMIRALTY,
POSTAL TELEGRAPH DEPT. &c.

TRADE MARK.

INVENTIONS, 1885

EDINBURGH, 1890.

ALL THESE GOODS ARE SHOWN FULL SIZE AND KEPT IN STOCK



SOLE AGENTS FOR J. C. MOUCHEL'S HIGH CONDUCTIVITY COPPER WIRE.

STRAIGHT DRAWN, BRASS, IRON and STEEL, ROUND HEXAGON and FLAT, all sizes kept in stock.

ESTIMATES FOR SCREWS AND TURNED PARTS ON RECEIPT OF PATTERNS.

CONSIDERABLE REDUCTION FOR LARGE QUANTITIES.

DYNAMOS & MOTORS

Armington-Sims High Speed Engines

FRIKART CORLISS VALVE ENGINES

FOR ALL PURPOSES.

Telegraphic Addresses:—
GREENWOOD, LEEDS.
OUNPLANE, LONDON.

TRANSMISSION OF POWER

FOR
CRANES
PUMPS, HAULING,
Coal Cutters, Machine Tools,

NOTE.—All machine tools made by us can be supplied specially arrange for direct electric driving.

GREENWOOD & BATLEY, LTD., ALBION WORKS, LEEDS
London Office:—16, Great George Street, Westminster, S.W. 1003

THE
WESTINGHOUSE ELECTRIC CO., LTD.

32, VICTORIA STREET, WESTMINSTER, LONDON, S.W.

Contractors for

ALL KINDS OF ELECTRICAL ENGINEERING UNDERTAKINGS,
CENTRAL STATION ELECTRIC LIGHTING,
ELECTRIC RAILWAY AND TRAMWAY SYSTEMS.

THE TESLA POLYPHASE ALTERNATING SYSTEM OF ELECTRICAL TRANSMISSION BY WHICH POWER, INCANDESCENT AND ARC LIGHTING, MAY BE MOST EFFICIENTLY SUPPLIED FROM THE SAME CIRCUITS.

THE WELL-KNOWN **SHALLENBERGER METER** FOR ALTERNATING CURRENTS AS APPROVED BY THE BOARD OF TRADE.

WURTS LIGHTNING ARRESTERS FOR CONTINUOUS AND ALTERNATING CURRENTS.

HIGHEST EFFICIENCY. **TRANSFORMERS.** LOWEST PRICES.

FOR FULL PARTICULARS, PRICES AND PAMPHLETS, APPLY TO THE OFFICES OF THE COMPANY, AS ABOVE. 4504

Telegraphic Address:—"ALCHEMIST, LONDON."
Telephone No. 3 348.

EPSTEIN

UNEQUALLED
FOR
MECHANICAL STRENGTH AND ELECTRICAL EFFICIENCY.
ELECTRIC
ACCUMULATOR

COMPANY, LIMITED,
28, Victoria St., Westminster, London, S.W.

THE

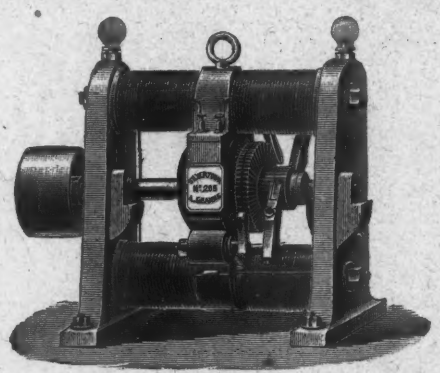
INDIA-RUBBER, GUTTA PERCHA, & TELEGRAPH

WORKS COMPANY, LIMITED,

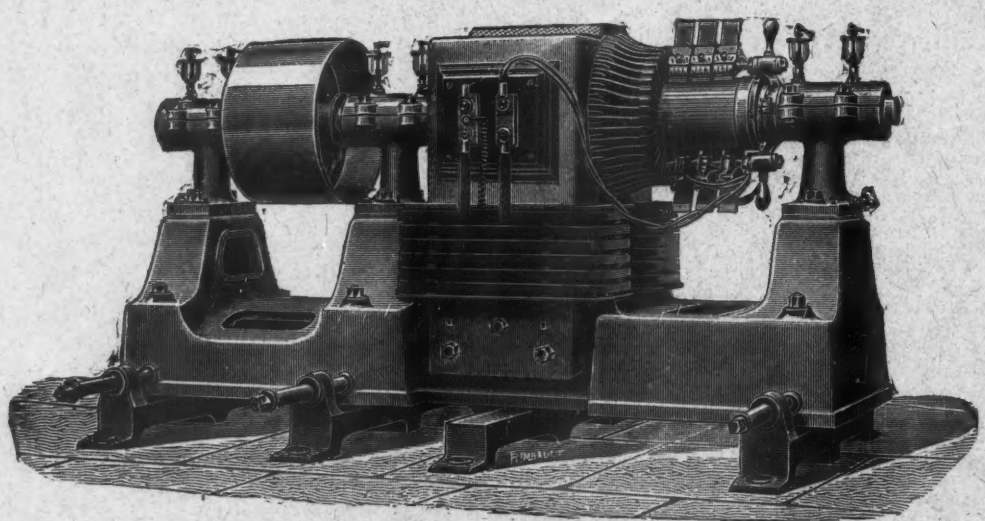
ELECTRICAL ENGINEERS.

SILVERTOWN DYNAMOS.

A. GRAMME, AS MANUFACTURED BY THE COMPANY IN 1877.



S.H. 50, AS MANUFACTURED BY THE COMPANY IN 1895.



MANUFACTURERS OF

CABLE (SUBMARINE, AERIAL, & UNDERGROUND).

Offices and Warehouses:

100 & 106, CANNON ST, LONDON, E.C., and 97, BOULEVARD SEBASTOPOL, PARIS.

Works: SILVERTOWN, ESSEX, AND PERSAN-BEAUMONT, FRANCE.

Telegraph Addresses:—Head Offices—Silvergray, London. Works—Graysilver, London.

BRANCH OFFICES

LIVERPOOL	54, Castle Street.	BRISTOL	28, Clare Street.	BIRMINGHAM	27, Albert Street.
BRADFORD (YORKS.)	1, Tanfield Buildings, Hustlergate.	MANCHESTER	9, Sussex Street.	GLASGOW	8, Buchanan Street.
SHEFFIELD	1, Fitzalan Square.	NEWCASTLE-ON-TYNE	59, Westgate Road.	BELFAST	33, High Street.
CARDIFF: Pierhead Chambers, Bute Docks.		PORTSMOUTH	49, High Street.	DUBLIN	15, St. Andrew Street

ESTIMATES AND PRICES ON APPLICATION. 4397

Printed by W. B. WHITTINGHAM & Co., LTD., 43—45, Charterhouse Sq., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.